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Household Equipment

Metropolitan Museum of Art

A Dutch Kitchen. David Teniers the Elder, Flemish School, 1582–1649.

Household Equipment

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The equipment does the work,
but the hand gets the credit.

—PERSIAN PROVERB

Preface

HOUSEHOLD APPLIANCES were not manufactured during the war years. When production started in 1945, the demand was so large that no changes in prewar models were made immediately. Within the past two years, however, rather extensive restyling of kitchen and laundry equipment has taken place, and a number of new models have been marketed for the first time. The expansion of electric power lines has increased the rural homemaker's interest in automatic washers, home freezers, dishwashers, and fluorescent lighting and has greatly stimulated production.

Up-to-date information on new appliances is desirable. In consequence, complete revision of this book has been necessary. Many new illustrations have been added.

The authors wish to express their sincere appreciation to the following people for generous assistance in securing valuable information: Miss Madge Dilts, Miss Myrtle Fahsbender, Miss Harriet Gormley, Miss Helen Holbrook, Miss Jessie McQueen, Miss Mary Webber, Mr. Paul Augenstein, Mr. James T. Gorton, Mr. F. H. McCormick, Mr. M. M. Scott, Mr. C. G. Segeler, Mr. William Shaw, Dr. Earl McCracken, and Mr. C. A. Thorp; and to all the manufacturers who have supplied illustrative material.

Contents

Introduction

THE TERM EQUIPMENT is generally used for those appliances provided in the kitchen and laundry of the home as distinct from the "furnishings" of the other rooms of the house. Equipment implies action in addition to use.

Efficient use of equipment includes the correct selection, arrangement, operation, and care of appliances so that the homemaker may accomplish the maximum amount of work with the minimum of effort in the shortest possible time. These objectives are the basis of the present interest in applying time and motion studies to household tasks.

At the same time greater emphasis is being placed on safety in the home. The need for this emphasis is realized when the results of a survey reveal that approximately 850,000 persons were injured in kitchen accidents during 1946, and an additional 5700 died from the same cause. Kitchens and laundries that are not free from hazards are not efficient.

In such a program, adequate lighting plays a very important part. Good lighting makes it possible to work more rapidly, more easily, more safely, and with less fatigue.

In the following chapters the selection, operation, and care of appliances will be considered first, then kitchen planning and home lighting will be discussed.

Materials Used in Household Equipment

FOR INTELLIGENT BUYING of household equipment it is important that the purchaser have some knowledge of the properties of the materials used in construction, since certain properties are essential for efficiency and durability. The characteristics that are desirable vary with the use to which the appliance is put.

The materials discussed in this chapter are grouped into (1) materials used largely in the framework, surface finishes, or trim; (2) materials used primarily for insulation; and (3) materials for table tops and floor coverings. No hard and fast line separates the groups. Nor is any group all-inclusive. This discussion will include the physical characteristics of the material that are important from the standpoint of construction, use, and care. Other properties will be considered in connection with the individual appliance.

FRAMEWORK AND SURFACE FINISHES

ALUMINUM

Aluminum, a metal found in all clay, constitutes approximately 8 per cent of the earth's crust. Aluminum is derived commercially from the clay, bauxite, of which the largest mines are in Arkansas. In its natural state aluminum occurs as aluminum oxide, which is separated from the other impurities in the clay by a highly technical chemical process. The resulting product, a pure white powder known as "alumina," is reduced to metallic aluminum by an electrolytic process, and the molten aluminum is cast into pigs or ingots. These ingots are practically pure aluminum since they rarely contain over 1½ to 2 per cent of impurities.

In the early years of the nineteenth century Sir Humphry Davy in England and Frederick Wöhler in Germany attempted the separation of aluminum from clay. Wöhler finally obtained a few small globules. A bar of aluminum, worth $90 a pound, was displayed at the World's

Fair in Paris in 1855 and attracted much attention. But it was not until after Charles Martin Hall, experimenting in his father's woodshed in Oberlin, Ohio, succeeded in 1886 in separating the metal by the aid of an electric current that the price became low enough to be within the reach of manufacturers of kitchen utensils.

Pure aluminum exists in three distinct physical forms, cast, hard-worked, and annealed. In the cast form pure aluminum is soft and ductile and finds little practical use. Cast aluminum cooking utensils usually contain 6 to 8 per cent of copper.

Pure cast aluminum, however, is the first stage in the production of aluminum sheets and wire. The pure aluminum pigs are melted and recast into rectangular slabs; the slabs are heated, and while hot they are rolled under enormous pressure into sheets ½ to ¼ inch in thickness; and the sheets are then cold-rolled into plates of any desired thickness. During the cold-rolling process the hardness and hence the tensile strength of the sheet metal increase and ductility decreases; as a result, sheet metal very high in tensile strength does not lend itself to construction processes. The manufacturer usually adjusts the tensile strength of the sheet by varying the thickness or by removing some of the hardness, due to cold-rolling, by annealing. Pure aluminum in sheet form is sufficiently pliable and ductile for the making of cooking utensils. Because of its ductility, it can be spun, drawn, and stamped. It can also be machined, riveted, and welded. Aluminum combines readily with most metals to form a large number of aluminum alloys of greater tensile strength than aluminum itself. Aluminum is a bluish white metal which will take and hold a high polish. It can be finished in a satin, frosted, or chrome-plated finish, can be etched, engraved, and painted. Aluminum is light in weight and has high thermal and electrical conductivity. It is fairly low in its emission power, or ability to give off radiant rays. It is also low in its thermal absorption power or ability to absorb radiation. It does not rust and if cold-rolled is very hard and durable.

Aluminum does not corrode readily but is affected by alkalies and certain food acids. The blackening of aluminum cooking utensils is usually due to the alkalies in the water or in the food products. Aluminum should not be washed with strong soaps, nor should scouring powder containing free alkali be used on it. Discoloration of aluminum may be removed by rubbing with an aluminum cleanser or with whiting or fine steel wool (grade 00), or it may be dissolved by

the acid of vinegar or lemon juice. After cleaning, the acids must be thoroughly washed off the aluminum.

Cast iron

Cast iron is produced from pig iron, which is made by fusing iron ore with coke, coal, or charcoal, and limestone in a blast furnace. The limestone acts as a flux and carries off foreign matter. The molten metal is drained from the furnace and cast into ingots, called pigs. Pig iron often contains 5 to 6 per cent of carbon and small amounts of silicon, manganese, phosphorus, and sulphur. If the carbon is present in uncombined form as flakes of graphite the iron is known as gray iron, but if combined chemically the iron is called white iron. Mottled irons are grades between these two extremes. Gray iron is tough and can be easily machined; white iron is hard and brittle and does not lend itself to machining. The mottled grades are used largely for castings unless machining and unusual strength are essential, then gray iron is used.

Cast iron will rust, is relatively low in tensile strength, and is brittle. It should be used only in castings such as water pipes and radiators which do not require special strength. Cheap tools made of cast iron are not durable. Mechanical parts of appliances made from cast iron are less lasting than those that are machined.

Cast iron is a fairly good conductor of heat, has high absorption and emission power, and because of its high thermal mass holds the heat well. Cast iron used for cooking utensils is comparatively inexpensive, is heavy, is difficult to keep attractive in appearance, and may discolor acid foods. It is used largely in griddles, skillets, and Dutch ovens. Utensils of cast iron must be seasoned before use to prevent sticking of food. The most common procedure is to wash the utensil thoroughly, dry, and brush with an unsalted oil, such as olive or mineral oil, care being taken to coat the entire surface. The utensil is then heated very slowly, either on top of the stove or in the oven, until the oil smokes and evaporates. If the oven is used, the procedure requires several hours at 350° F.

Malleable cast iron

When articles made of cast iron are given a long annealing at a high temperature, part of the carbon on the surface is oxidized and the metal loses its brittle characteristics. Castings so treated are known as malleable cast iron.

Armco

Armco iron is a trade name given to commercially pure iron produced by the open-hearth process. The manufacturers guarantee a maximum of 0.16 per cent impurities. Armco iron is rust-resisting, hard, and of high tensile strength. It is comparatively high in electrical conductivity, has unusual welding properties, and enamels well, owing to its relative freedom from occluded gases.

Steel

Ordinary steel is made by refining pig iron to remove a portion of the impurities, casting it into ingots, and rolling or forging it into the finished form. Steel is of various grades depending primarily upon the amount of carbon present. Hard steel contains 1 per cent or more of carbon, whereas soft steel contains less than 0.1 per cent of carbon. Between these two is a wide range of products differing chiefly in carbon content.

Hard steel is hardened by heating and quenching in water. It is used for articles such as knives and razors where a keen cutting edge is desired. Soft steel may be welded and worked and formed cold.

Stainless steels

Stainless steels are alloys of steel and chromium or of steel, chromium, and nickel. They have high tensile strength and are resistant to corrosion. Stainless steels take and retain highly polished surfaces, do not scratch with scouring, and are not affected by food acids or alkalies. They have relatively low heat conductivity, absorption, and emission power. When used for cooking utensils the low conductivity is partially overcome by the use of light-gauge metal, by electroplating the bottom of the utensil with copper, or by using two thin sheets of stainless steel with a core of copper between. The last are known as "copper-clad" and "triple-ply" utensils.

Stainless steel utensils that are not combined with copper frequently develop hot spots and require very low heat. Food cooked in them has to be watched carefully to avoid burning.

Some stainless steels develop a brownish tinge if overheated. This is a slight oxidation on the surface of the metal brought about by excessive heat. It can be removed with a mild scouring powder.

Stainless steels are attractive in appearance and, because of their hard, dense surface, require comparatively little care. Washing with

ordinary soap and water, plus an occasional cleaning with a good scouring powder, is sufficient.

Galvanized iron

Galvanizing is the process of coating a base metal with zinc to protect it against rusting. Iron and steel are commonly used as the base metal.

Zinc is not as pliable and ductile as iron and steel, and hence galvanized iron does not lend itself to most forming and drawing operations. Heavy coatings of zinc are likely to crack and peel off under severe strain. Galvanized iron is best adapted for flatwares or for utensils in which the forming strains are slight. It is used in buckets, washboards, lids of fruit jars, and articles that are in constant contact with moisture. Zinc darkens with use but may be brightened by scouring powder.

Tin

Tin was early used as a protective covering for metals. It was mined in England in very early times and about 1670 was employed in the manufacture of utensils for the home. The extensive production in the United States dates from 1892.

Tinware, as used in the home, consists of sheet iron or more frequently sheet steel coated with a film of pure tin. Tinplate is graded according to the thickness and quality of the base plate of steel and of the tin coating. There are two grades of tinplate, charcoal and coke, depending on the fuel used in the manufacture of the steel. The cheaper grade is made with coke. "Block" tin is a term applied to the most heavily coated sheets, and refers to the quality of the tin.

Steel with a heavy coating of tin is known as "steel retinned ware" and is used in institutional equipment.

The manufacture of tin plate is similar to the manufacture of enameledware. (See p. 6.) The steel sheets are annealed and pickled before the tinning process, and the tin coating must be evenly applied. Unlike the manufacture of enameledware, the tinning is done before the sheets are made into utensils, not afterward. This is possible because the tin coating is pliable and shapes with the steel base.

The quality of the tin coating largely determines the life of tinware. Perfect sheets are made into utensils of better grade. The presence of tiny pinholes in the tin exposes the steel base, which corrodes rapidly when reached by moisture. Tinware is readily affected by food acids and should not be used in cooking such foods as to-

matoes and rhubarb. Tinware is light in weight, is a good conductor of heat, and when new is low in its absorption and emission power.

Tin darkens with use, and hence its absorption power for radiant heat changes rapidly. This surface tarnish furnishes a protective coating for the tin; therefore tin utensils should not be scoured simply for the sake of making them bright.

Scraping tin scratches the surface and may expose the iron or steel base, which rusts on exposure. For ordinary care tin utensils should be washed with soap and water, rinsed, and dried thoroughly. If food has dried to the surface of the utensil it can easily be removed by adding a weak soda solution, heating for a few minutes, and then washing thoroughly.

Porcelain enamel

Porcelain enamel is a glass-like substance fused upon the surface of a metallic base. The metals used are principally sheet iron, sheet steel, and certain types of cast iron.

The process of enameling was discovered in China centuries ago. From there it was carried to Europe and later to America. At present, enameled appliances of one kind or another find extensive use in nearly every home: cooking utensils, ranges, refrigerators, washing machines, table tops, and wall tile.

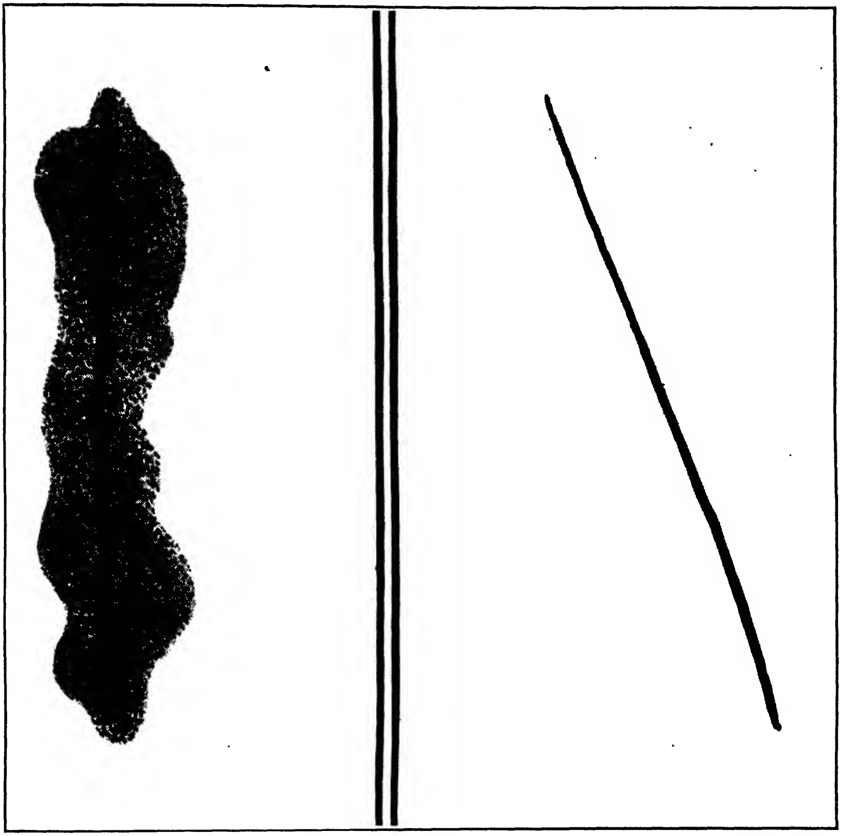
The porcelain enamel coating is made by fusing the mineral ingredients together at high temperature until a clear liquid is formed. The molten glass is drawn off into cold water and, owing to the sudden contraction, breaks into fine particles known as "frit." The frit is pulverized, mixed with clay and water to form a thick cream, and stored in barrels to age.

The base metal to which the enamel coating is to be applied is cut, stamped, and drawn into the desired shape. Any wrinkles are removed by "spinning," handles and spouts are welded on, and the utensil is annealed. The utensil is finally "pickled" in acid to remove all impurities from the surface, rinsed, and dried. It is then ready for the enamel.

Before the finish is applied the metal is "bonderized." Bonderizing is a patented process [1] in which the steel is covered with a very thin coating of iron phosphate, which is rust-resisting and so protects the steel and also seems to increase the bond between the steel and the surface finish. (Fig. 1.)

[1] Developed by Parker Rust Proof Co., Detroit, Michigan.

The first coat, applied in liquid form, is usually dark blue because it contains a certain percentage of cobalt oxide which has a strong affinity for iron. The base metal is dipped into the liquid enamel, or the enamel is sprayed onto the metal. It is then dried and placed



Westinghouse

FIG. 1. Bonderized steel is very resistant to rusting; the untreated metal corrodes easily.

in the enameling furnace. Temperatures in the furnace of 1400° to 1800° F. cause the glass to melt and fuse into the pores of the base metal. This first coat serves as a binding between the base metal and outer coats.

Enameled appliances may have one, two, or three coats, depending upon the product. If sheet metal is used as the base, the remaining coats are usually applied in liquid form, dried, and heated until they fuse, forming a smooth surface. If cast iron is used as the base

the remaining coats are frequently applied as dry powder. The powder is sifted onto the surface of the piece when it is withdrawn from the furnace at a bright cherry-red heat. The piece is then replaced in the furnace and heated until the coat has fused.

Colored porcelain enamels are produced by the addition of metal oxides, which fuse into the enamel; hence colored enamels never fade or wear off.

Enamel of better quality used on sinks, ranges, and cooking utensils is especially treated to give an acid-resistant glaze.

An enameledware product has practically all the properties of a glass product. It is non-soluble, will not rust or discolor, and is not affected by atmospheric conditions. Its thermal conductivity is determined to a large extent by the base metal. It has high absorption and emission power. If subjected to sudden extreme changes of temperatures or to undue strain, enamel will chip or crack.

Ordinary porcelain enamels are affected by strong acids, and bowls made of enameledware are marked by metal spoons and beaters.

Foods have a tendency to stick easily in enameled cooking utensils because of the comparatively porous surface. Food burned on the surface is difficult to remove. Porcelain enamel should be washed with a mild soap and water or scoured with whiting or a very fine scouring powder. Coarse scouring powder or strong acids destroy the glaze.

Copper

Copper was one of the earliest metals used. It is separated from its ores and cast into ingots, from which it is made into sheets, wire, and castings. Pure copper is one of the best-known conductors of electricity and of heat. It is malleable and ductile and lends itself readily to various forms of manufacture. Copper tarnishes easily, however, and requires constant burnishing to be kept bright. In cooking utensils the inner surface is usually tinned to avoid corrosion.

The tarnish formed on copper is copper carbonate and is removed by friction or may be dissolved by a weak acid. Rottenstone mixed with oil to a creamy consistency is a good frictional agent. After the cleaner has been applied the metal should be polished with a soft cloth. Oxalic acid solution, buttermilk, or vinegar quickly dissolves the tarnish on copper. After cleaning with an acid the metal should be washed in water and dried thoroughly. Rubbing with dry whiting after drying will give the metal a brighter luster than when acid alone is used.

NICKEL AND CHROMIUM

Nickel is a white malleable metal, which is highly resistant to the action of air and water and is not affected to any extent by food acids and alkalies. Its thermal conductivity is approximately one-sixth that of copper. Chromium is a grayish white, hard, brittle metal, also not affected by air, water, or food acids and alkalies. Large deposits of nickel are found in northern Canada, and chromium comes from South Africa.

Chromium and nickel, because of their high resistance to corrosion and their metallic luster, are extensively used in electroplating. The base metals are usually iron, steel, copper, zinc, or aluminum. The process takes place in a series of steps. The base metal is polished, copper-plated, again polished, then coated with nickel, polished, and finally plated with chromium. The copper plating is apparently necessary because of the better adhesion of the nickel and chromium to copper than to iron.

Appliances electroplated with chromium and nickel have a highly polished finish that is attractive and durable if properly cared for. Nickel plating is a soft finish and is easily destroyed by abrasives. Nickel plating tarnishes slightly but is easily cleaned with soap and water or with whiting and alcohol; chromium plating does not oxidize and needs only to be wiped with a damp cloth. Nickel plating frequently discolors permanently if subjected to an excessively high temperature. Chromium-plated cooking utensils should be washed with soap and water but should never be scoured with metal sponge or metal wool.

Because of its high resistance to the disintegrating effects of heat and oxygen, an alloy of nickel and chromium is commonly used for the heating elements of electric appliances. The metals are usually combined in the ratio of four parts of nickel to one of chromium. Wire of this alloy is sold under such trade names as Nichrome and Chromel.

MONEL

Monel is a trade name for a nickel-copper alloy of high nickel content. Monel metal is of silverlike luster, has high tensile strength, is very resistant to denting, scratching, and staining, does not corrode, and is unaffected by food acids and alkalies. It takes and retains a good polish. Monel metal is a comparatively poor conductor of heat. It is used for sinks, table tops, laundry equipment, oven linings, various appliances, and fittings and trimmings.

Glass

Glass in its various forms finds many practical uses in the home. For cooking utensils, with which the housewife is chiefly concerned, it must be heat-resisting. The coefficient of expansion of glass is high in comparison with the various metals, and as a result it cannot be subjected to extreme changes of temperature.

Heat-resisting glass is hard and if handled with care is strong and durable. It is a comparatively poor conductor of heat but has high absorption and emission power. Its high absorption power makes it particularly adaptable for use in oven utensils, since most ovens have a relatively high percentage of heat transfer by radiation. A flame-proof glass has also been developed which is used in a variety of surface utensils.

Earthenware

Earthenware is a clay product. Various kinds of earthenware are manufactured under different trade names. These products vary chiefly in the quality of clay, the method of making, and the glaze which is used. Earthenware is opaque, comparatively coarse in texture, and porous when fractured. It is little affected by food acids and alkalies or by sudden changes in temperature.

Plastics

Plastics are made from eight common raw materials—coal, air, lime, water, petroleum, cellulose, sulphur, and salt. Over a hundred different plastics are now available. These have been developed to have a wide variation in physical characteristics. Hence their use is increasing rapidly in the construction of all types of household equipment. Plastics are light in weight, colorful, easy to clean, and durable. To a greater or lesser degree plastics have become a part of all up-to-date household equipment. They contribute to the light weight, strength, good looks, and resistance to moisture and deterioration, and make the equipment easy to care for.

INSULATION

Mica

Mica is one of the most commonly occurring minerals. Chemically it is a silicate. Two varieties, white and amber mica, are used commercially.

In mining, the mica crystals usually break up into plates an inch or more in thickness. The plates are passed through a cleaning and trimming process and are then split by hand with a dull-edged, sharp-pointed knife. Owing to the almost perfect cleavage of the crystals, the split pieces are exceedingly thin, not exceeding 0.002 inch in thickness. These thin pieces are built into mica sheets by the use of shellac or similar binding materials. In the best grades of mica, which are free from impurities, the sheets are highly transparent. They are soft, flexible, and elastic, but strong. Mica is a fairly good conductor of heat and a poor conductor of electricity. These two properties make it particularly adaptable for use as an electrical insulator in electrical heating appliances. It is not considered the most desirable electrical insulator in appliances operating at high temperatures because excessive heat continuing over a period of time brings about a breakdown of its insulating ability.

Asbestos

Asbestos is a term used to designate a group of minerals which have a fibrous crystalline structure. The principal asbestos of commerce is found in serpentine, which is mined chiefly in Canada and Rhodesia.

Asbestos occurs in slender, flexible fibers that are easily separated from the rock. After separation the fibers are graded according to length and fabricated into different types of material. The long fibers are spun into yarn and woven into cloth; the short ones are pressed into sheets. Asbestos is light in weight, has low thermal conductivity and high heat-resisting qualities, and is incombustible, all of which makes it a good insulating material. It is used principally in cords on heating appliances. Asbestos is not moistureproof unless specially treated.

Rock wool

Rock wool is a mineral product made from calcium magnesium silicate. The stone is obtained from open quarries and is heated until melted. While in the molten condition, the rock is blown into cooling chambers. The resulting product is a fine white fibrous material of low thermal conductivity. After the material has cooled, it is manufactured into a variety of products as felts, flexible blankets, pipe coverings, insulating bricks and blocks, acoustic plaster, and insulating cements.

As insulation for household equipment, rock wool is used in granulated form and in bats and flexible blankets. Rock wool will not burn, deteriorate, or attract vermin or mice. It is chemically stable and durable but is not moistureproof unless specially treated. Certain manufacturers treat rock wool in the molten state so that the fibers are annealed as they are blown. This annealing process tends to toughen the fibers and render them resistant to moisture.

Glass

The use of ordinary glass for insulators in electric wiring is familiar. Glass for heat insulation has come into use comparatively recently. There are two kinds, glass fiber or wool and spun glass. Glass wool is made from liquid glass blown under pressure. In making spun glass, the molten mass is drawn into threads and wound on a revolving drum.

Both varieties are odor-, moisture-, and verminproof and will not settle. Spun glass is used quite extensively as insulation for ranges.

Cork

Cork is obtained from the bark of the cork oak tree. Ability to retard the flow of heat, freedom from capillaries, and resiliency are properties of cork which make it of great commercial value.

Cork is used in several different forms: granulated cork, cork board, and cork tile or bricks. For insulation in household equipment cork board manufactured from cork waste is most efficient. The cork is ground and placed in iron molds where it is compressed to the desired thickness, and the mold is then baked for several hours. The heat during the baking process liquefies the natural gum of the cork, and the gum binds the cork particles together. The gum also acts as a waterproofing agent.

When examined under the microscope, cork appears to be a mass of tiny sealed air cells. Baking increases the volume of confined air by driving off all the moisture and part of the volatile matter. The heat spreads the natural waterproof gum over the surface of each separate granule. As a result, cork board absorbs less moisture and is a better insulator than natural cork.

Cork board will char but will not burn. It is light in weight, odorless, odorproof, practically moistureproof, and resilient. In household equipment cork board is used as an insulating material in refrigerators. It is also cut into blocks and used as floor tile.

TABLE TOPS AND FLOOR COVERINGS

Linoleum

Linoleum is a product made from cork, oxidized linseed oil, and burlap. Most manufacturers make at least four varieties: plain, Jaspé, inlaid, and printed. They may be purchased in a wide choice of colors and designs.

Linoleum is used largely for floor and table-top coverings. It is resilient, does not crack or mar easily, and is comparatively inexpensive.

Plain linoleum is of solid color without design. The thicker gauges are known as battleship linoleum because they are used in the United States battleships. Jaspé linoleum is plain linoleum with a two-tone striated appearance instead of one solid color. In Jaspé linoleum the graining goes through to the burlap. Inlaid linoleum is made in patterns with the colors also extending through to the burlap.

Printed linoleum, as the name implies, is plain linoleum with the designs printed in heavy and fairly durable oil paints. Printed linoleum is not as durable as the plain, Jaspé, or inlaid, because the design does not extend through to the burlap and will wear off with constant use. The painted oil surface, however, is easy to clean.

Linoleum is made in several thicknesses to provide for different floor requirements. The standard gauge, which is approximately $5/64$ inch, is usually used in the home.

Most linoleums give best service if laid over a lining felt which in turn is cemented to the wood floor. The felt takes up any expansion and contraction of the wood and prevents the linoleum from buckling or splitting. It also makes the floor warmer and more resilient. Seams should be protected with waterproof cement. If the floor is concrete, a felt lining is optional. It helps, however, in taking up the irregularities that are always present in concrete and adds to the resiliency. One type of linoleum is made with a "factory-applied adhesive back" and is laid directly on the floor. Linoleum is not recommended for floors that are in direct contact with the ground, because of dampness.

For table tops linoleum should be cemented directly to the wood with waterproof cement.

If properly laid and cared for, linoleum is durable and easy to keep clean. Some linoleums are given a wax finish in the factory; others require waxing as soon as laid. Wax fills the pores and seals

the surface, thus preventing dirt from being ground in. It also helps preserve the natural resiliency of the material. Paste wax is recommended for the first coat as it is heavier than liquid wax. After polishing, a second coat should be added. Liquid wax is easier to apply and as a result many homemakers prefer it. Under normal conditions daily brushing with a dry mop and wiping with a damp cloth once a week are sufficient. For floors that require more thorough cleaning, use a soft mop with warm water and a mild soap solution. Hot water, strong soaps, and cleaning agents should never be used on linoleum. Wash only a small portion at a time, rinse, and dry thoroughly. Scrubbing tends to remove the wax finish and make rewaxing necessary.

Wall linoleum

Several manufacturers make a wall covering which is an inlaid linoleum composition processed on a woven flexible fabric backing. It is resilient, does not chip or tear readily, is stainproof and waterproof, and is not affected by sunlight. It is particularly suitable for kitchen, bathroom, hall, and nursery walls. It requires little care and can be cleaned with a mild soap and warm water.

Linoleum tile

Linoleum tile is made from cork, oxidized oils, and color pigment. It is sold under such trade names as Linotile and Treadlite tile. These tiles come in several gauges for different flooring requirements and may be obtained in plain-colored, variegated, and marbleized patterns. Linoleum tile is more resilient than battleship linoleum, is durable, easy to clean, and simple to repair. It can be laid over wood, concrete, or metal subfloors. Its use, however, is not recommended over concrete where there is dampness. When it is laid over wood, a felt lining should be used. Linoleum tile should be waxed and given the same care as linoleum.

Cork tile

Cork tile is manufactured from pure cork compressed in molds and baked. The heat in the baking process melts the gum or resin in the cork and cements the particles into a firm mass. The heat also produces several natural shades of brown, depending upon the duration of the heating process. Cork tile gives a quiet as well as a very resilient floor covering. Cork tile can be laid over wood, concrete, or metal. When it is used over a wood floor, a felt lining is recom-

mended. Cork tile should not be used on concrete floors in direct contact with the ground or where there is excessive moisture. After installation, cork tile should be treated with a filler, followed by several coats of cork tile finish or by several coats of wax, and thoroughly buffed with a machine.

Asphalt tile

Asphalt tile is manufactured from asphalt, asbestos, and mineral pigments, in both plain and marbelized patterns. Asphalt tile is resilient, fire-resistant, odorless, and resistant to mild alkaline or acid solutions, and it will not absorb water. It does not become slippery when wet and is easily cleaned with soap and water. Asphalt tile is not affected by moisture and can be laid over unwaterproofed concrete. It is particularly suitable for basements. It is affected by oil and grease and unless specially treated should not be used where these are present.

Rubber tile

Rubber tile is manufactured from a good grade of rubber with a filament reinforcement and comes in a variety of plain and marbleized colors. It can be installed over wood, concrete, or metal. When it is installed over wood, a felt lining is recommended. Its use is not recommended over wood or concrete in direct contact with the ground or where considerable dampness, oil, or grease is present. Rubber tile gives a floor covering of high resiliency, but some makes are not entirely resistant to dirt and stains. It should be swept daily and given an occasional waxing. If scrubbing is necessary, use ¼ cup of trisodiumphosphate (Oakite or Climalene) in a pail of lukewarm water. Wash a small portion at a time, rinse, and dry thoroughly. Do not wash for at least a week after installation.

Formica

Formica is a laminated synthetic material which is chemically inert, hard, and resistant to wear and to moisture. It is available in a wide variety of colors and patterns and in satin and polished surfaces. In the home it is used largely for table tops.

Micarta

Micarta is a laminated, hot-molded material which is dense, hard, and strong. It gives a finish that is extremely durable and will not scratch or dent easily. It is resistant to moisture and chemicals and

is used largely in the home for wall paneling and for table tops. Micarta is attractive and easy to clean.

Summary

The efficiency and durability of household appliances depend in part upon the materials used in their construction. For convenience, materials are grouped into those used in the framework and surface finish of appliances, those used for insulating purposes, and those used for floor coverings. Methods of manufacture and outstanding properties which determine the choice are considered.

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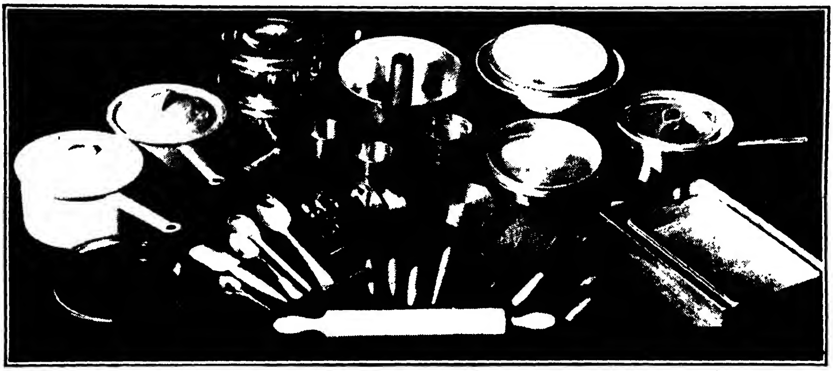
2

Kitchen Utensils

KITCHEN UTENSILS include everything from a cookie cutter to a roasting pan and from a paring knife to a pressure cooker. (Fig. 2.) They are all used in operations performed by hand. For convenience and simplification the equipment may be grouped into (1) utensils used in surface cookery, (2) utensils used in oven cookery, and (3) accessory utensils used in the preparation of food.



Household Finance Corp.

FIG. 2. Kitchen utensils.

The first group includes kettles, saucepans, frying pans, Dutch ovens, waterless cookers, steamers, and pressure pans and cookers; the second group, roasting pans, cake pans, muffin pans, biscuit and cookie baking sheets, baking dishes, and casseroles; the third group, measuring cups and spoons, sifters and strainers, egg beaters, mixing bowls, can openers, knives, forks, spoons, and spatulas, knife sharpeners, graters, slicers, molds, and fruit juice extractors. Can sealers may also be considered in group 3. Other small pieces of equipment might have been included, but those selected are in most common use.

Any utensil should be judged on construction, efficiency, and care required. It must be well made and of a material fitted to the purpose for which it is to be used. It should be durable, simple in design, and of suitable size and shape. To be efficient the utensil must be so easy to operate that, in a reasonable length of time and without

undue expenditure of effort, it will accomplish the task for which it was made.

One utensil with a number of uses is a better choice than several suited to only one job. The work required to keep the utensil clean must also be considered.

Materials used for surface cookery utensils

Utensils used in surface cookery are of iron, stainless steel, aluminum, either cast or stamped, porcelain enameledware, heat-resistant glass, or an alloy.

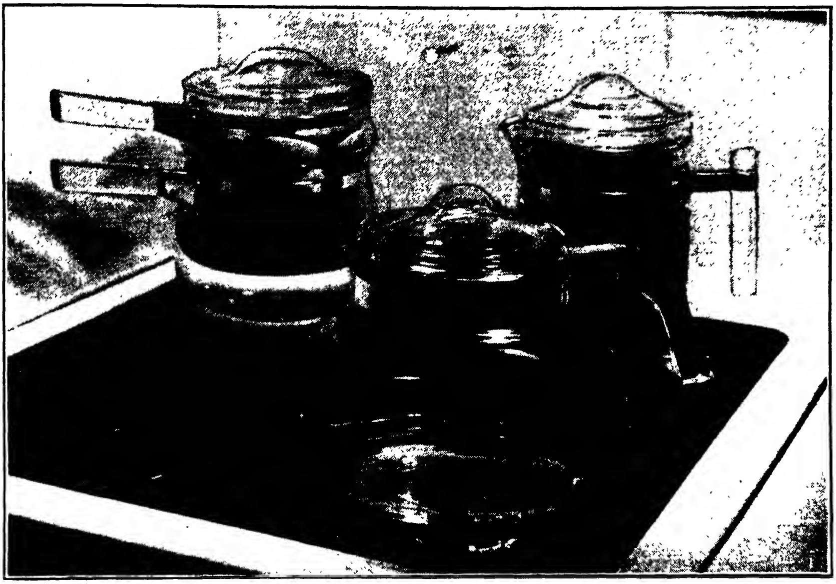
Aluminum containing a fraction of magnesium is the most strain-resisting variety and makes beautiful castings. Good castings are not made from remelted metal. Manufacturers of cast aluminum utensils, in cooperation with the Bureau of Standards, have been developing standard specifications and methods of test for their products, so that corrosion and staining under normal conditions of use may be reduced to the minimum. If a manufacturer complies with the proposed standard, his utensils will have the letters CS (Commercial Standard), enclosed in a circle, cast or stamped into the outside bottom of the utensil.

Pitting may occasionally occur when very saline water is used or when moist food is allowed to stand in a kettle of alumium, but more frequently it results from the molecular structure of the sheet from which the utensil is stamped.

Iron and aluminum are good conductors of heat; in contrast, porcelain enameledware, a non-homogeneous material, and glass absorb heat readily but conduct it rather poorly. In enameledware hot spots may develop and the food stick and even scorch. With thicker vessels this difference tends to disappear, but, in general, utensils of glass and enameledware are more satisfactory when a fairly large amount of liquid is used. On the other hand, aluminum discolors with alkalies, whereas steel, ~~enameledware~~, and glass do not, and they are preferred for ~~cooking white~~ sauces, custards, and lemon pie filling. Stirring should be done with a wooden spoon to avoid scratching the surface.

Enameledware may crack and chip if carelessly handled, but the better grades will give long and satisfactory service when used with care. Select utensils that have a smooth, even coating. Those with fine cracks, thin places in the enamel, and other blemishes are a poor choice.

A commercial standard for porcelain enameledware has been established by the Enameled Utensils Manufacturers Council and the Bureau of Standards. Utensils should carry a label that tells whether it is single- or multicoated and whether it complies with the standard for its type. Research workers in this field have been endeavoring to increase the resistance of enameledware to blows and rapid changes of temperature.



Corning Glass Works

Fig. 3. Flameware utensils make "peeking" unnecessary.

Top-of-the-stove Pyrex utensils, known as Flameware, permit the depth of liquid and progress of cooking to be seen without removing the cover. (Fig. 3.) They will break if subjected to sudden extremes of temperature and should not be set on a cold surface or soaked in cold water until they have cooled.

High-grade stainless steel utensils are expensive but provide lifelong use. Inferior quality should be avoided. Steel does not spread the heat as evenly as aluminum, but saucepans and skillets of steel with copper bottoms are of superior efficiency, for copper outranks all other materials in heat conductivity. The copper extends over the lower edge and part way up the side. It is deposited on the steel by a special electrolytic process. (Fig. 4.)

Cast iron, in spite of its unattractive appearance and heavy weight, is a favorite material with many housewives. It heats slowly and evenly and retains heat well so that it is especially desirable for long cooking processes and requires the minimum amount of watching.

The material of the pan has less to do with its thermal efficiency than is generally supposed. The thermal resistance of the material is very small—often not more than 0.5 per cent—compared to that of

Revere Copper and Brass, Inc.

FIG. 4. A "copper-clad" stainless steel saucepan.

the water film inside the pan. Moreover the gas film on the outside of the pan has a resistance many times that of the water film, so that the conductivity of the pan material itself is not a significant factor in determining the heating efficiency. Non-corrosive materials have less film and are, therefore, preferable. Stirring tends to reduce the liquid film, and boiling has a similar effect.

Experiments at John Hopkins and other universities entirely discredit the theory that cancer or other diseases may be caused by foods cooked in aluminum utensils.

SAUCEPANS AND KETTLES

Aluminum saucepans come in various thicknesses; but very thin ones should not be purchased since they tend to dent, and dented pans waste fuel. Black-bottomed pans have been found to be slightly

more efficient than light-colored ones on units transmitting heat largely by radiation, but the difference in efficiency is not sufficient to necessitate the buying of a black-bottomed pan if the light-colored one is preferred. When purchasing pans with black bottoms, it is well to select those on which the black finish is guaranteed to be comparatively permanent. Pans with seamless sides and flat bottoms that fit the units are recommended. A well-rounded union between sides and bottom simplifies cleaning.

The edge of the pot may be turned or rolled, or the pot may be rimless. A rolled edge, pressed close to the sides to form a flat bead with no crevice where dirt may collect, is a satisfactory finish. A lip on either side is a convenience. When covers are used either the pan or cover must have a beveled edge, in order that the cover may fit tightly. A close-fitting cover permits maintenance of the boiling temperature when low heat is used. A dome-shaped cover increases the capacity of the pot, but the flat cover with a recessed knob permits stacking of pans for storage or when cooking an oven meal.

Spouts should be shaped to direct the liquid toward the center of the pouring stream without its spilling over the sides. The edge should be thin and sharp to prevent dripping down the outside of the vessel.

If the pot or pan has a handle it should be of heat-resistant material and of a shape and length comfortable for the hand. Two handles, one on either side, are found on pots; the pan has a single one; and the kettle, a bailed handle. Too long a handle may overbalance the pan or get in the way; too short a handle increases possibility of burns. Handles are joined at different angles—some at almost a right angle, others at various acute angles. In selecting a pan, different handles may be tested, and the one chosen that the purchaser finds most convenient for lifting. Be sure that the handle is fastened securely, so that it will not wear loose, and with a smooth joint, to prevent dirt from collecting. If the handle is of wood, a metal shank must connect it to the pan to eliminate any likelihood of the wooden handle being over the flame. A detachable handle should be tested for ease of operation and security. A ring or hole in the end of the handle allows the pan to be hung up. (Fig. 4.)

The size of the pan should be proportional to the amount of food to be cooked. Usually a large amount cooks more rapidly if it forms a thin layer in a large kettle than when it is a deep layer in a small one.

Frying pans

Frying pans or skillets are commonly of aluminum, stainless steel, cast or sheet iron, and Pyrex Flameware. Sheet-metal utensils are likely to warp, and foods tend to stick and burn in them. A new iron skillet should be seasoned: it should be scrubbed thoroughly in hot soapy water, rinsed, and dried; then rubbed all over with cooking oil or unsalted fat and placed in a warm oven for several hours; washed again and dried. It is then ready for use. Always dry it carefully after each washing to prevent rusting. Some iron frying pans are plated with chromium, satin-finished on the inside and on the bottom, brightly polished on the outer side. Their wearing ability depends upon the thickness of the plating. Food often tends to stick to plated frying pans. There is a stainless steel skillet, similar to the saucepan, with a copper bottom and lower edge. Handles on skillets are frequently in one piece with the pan. A deep pan with a lid may be used as a chicken fryer.

Dutch oven

The iron kettle known as the Dutch oven dates from colonial days; only recently has it been made of cast aluminum. (Fig. 5.) Dutch ovens were brought to America by the Pilgrims. As is well known, the Pilgrims spent some years in Holland before coming to America. The *Mayflower* was a tiny vessel and baggage was limited. The Dutch oven could be used for such a variety of cookery that it took the place of several other pots and pans and was, therefore, a favorite utensil of the early settlers.

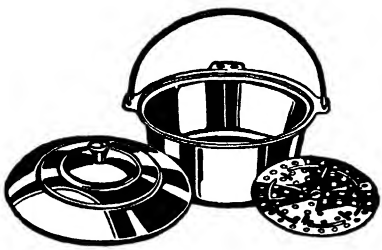


Fig. 5. Aluminum Dutch oven.

The Dutch oven comes in different sizes and has a rounded cover which adds greatly to its capacity. The cover fits closely to keep in the steam. The oven may be used with or without a rack. The chicken fryer may double for the Dutch oven very satisfactorily.

Like the range oven, the Dutch oven may be used for cooking several foods at one time. Meat may be seared, placed on the rack, and vegetables placed around it; a separate vessel of fruit may be included. A small amount of water is added to the bottom of the oven, and after steam has formed the heat is turned very low and the cooking continued for a long enough time to give tender products. Oc-

casionally, more water must be added, but usually this is not necessary if the heat is kept low and the cover not lifted, so that steam is not lost.

Waterless cooker

The "waterless" cooker, so called, is a product of the aluminum age, but waterless cooking itself is not new. Waterless is somewhat of a misnomer, since two or three tablespoons of water are often added, or at least the vegetables are moist from having been washed. Even when no water is supplied from either of these sources, most food products contain a high percentage of moisture, part of which is extracted in the cooking process and is the source of the steam.

Cooking in a small amount of water tends to preserve the vitamin and mineral content of the food. Green vegetables usually should not be cooked in a tightly covered utensil, or for a long time, since the volatile vegetable acids will change the bright green color to an olive green or brownish hue, which is most unattractive. If a cover is used and is lifted once or twice during the first few minutes of the cooking process, to allow the volatile constituents to escape, change in color may be avoided. Green vegetables cooked in hard water do not show this color change. When strong-flavored vegetables such as onions, turnips, and cauliflower are old, they are best cooked uncovered in a fairly large amount of water; but young vegetables of this type may be cooked in a small amount of water if the cover is lifted occasionally.

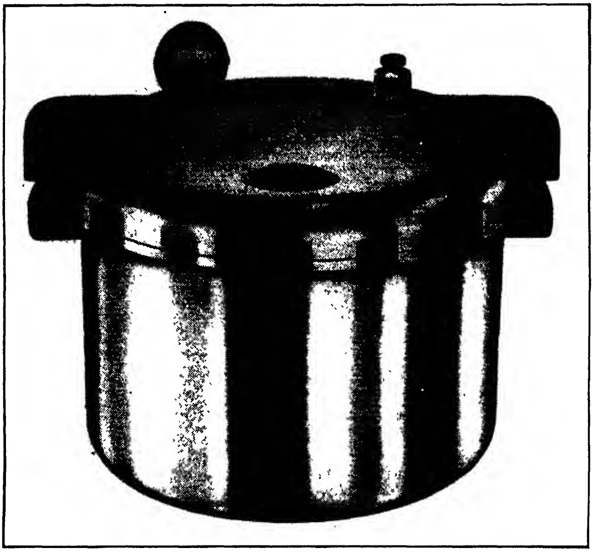
Waterless cooking may be done in any container that has a tight-fitting cover to hold in the steam, but the heat must be kept very low. Because of the even spread and good retention of heat by iron and aluminum, utensils of these materials are usually preferred.

Pressure cooker

Several makes of pressure cookers are on the market, but all of them operate on the same general principle. The boiling point of a liquid varies directly with the pressure applied to the surface. When water is heated in an open kettle, the temperature of the water gradually rises to the boiling point, but gets no hotter, for at that point heat is used up in the change to steam (heat of vaporization). The steam pressure cooker is a heavy pot or kettle with a closely fitting cover tightly fastened. Steam is confined within the cooker and creates pressure, which increases the temperature at which the water will boil, and, therefore, the temperature of the steam itself.

Since the manufacture of the pressure saucepan, larger cookers are used chiefly for the processing of canned foods, especially meats and non-acid vegetables.

The ancestor of the pressure cooker was first used in Spain. It was a heavy iron bean pot which made use of steam pressure to increase the temperature and shorten the cooking process.



Lakeside Aluminum Co.

FIG. 6. Pressure cooker with combined safety valve and petcock.

Modern pressure cookers are made of pressed or cast aluminum, tinned steel, or porcelain enamel on steel. They are molded in one piece without seams or joints. (Fig. 6.) The rims of pot and cover are accurately planed to form a tight union through which steam cannot escape. They should be kept clean and should not be scratched. One company uses a ring of neoprene on the cover, which gives a more reliable seal against the metal than metal to metal. It is long wearing and will not impart off-flavors to the food.

The devices for registering and regulating the pressure are on the lid. They are pressure gauge, safety valve, and petcock. The gauge usually is an open-faced dial, indicating pressures from zero to 20 or 30 pounds, and sometimes also corresponding temperatures. A pointer on the dial moves over the scale.

Another type of gauge is entirely of metal and is cylindrical in construction. A central core, on which the pressures are indicated by

a series of lines, protrudes from the outer shell as the pressure increases. In the cookers marketed during the war, pressure was controlled by accurately machined weights placed over a vent in the cover. The first weight was used for 5 pounds pressure; an additional weight was added for 10 pounds; and a third, for 15 pounds. The heat was controlled to allow the continuous escape of a small amount of steam.

Tests by Baragar at the University of Nebraska showed many gauges seriously off calibration. He recommends (1) gauges that when new are accurate to within ½ pound pressure and will maintain this accuracy with careful use, (2) a 2-inch dial with the scale spread over 180° of the face, and (3) discontinuation of marking of temperatures on the dial since such temperatures are correct only at sea level and when the calibration is exact.

Most canning operations are carried on at 10 pounds pressure, which many dials indicate is equivalent to 240° F. This is true only at low altitudes. Monroe points out that the temperature is 240° F. only when the atmospheric pressure plus the pressure in the pan equals 25 pounds. At low altitudes atmospheric pressure is approximately 15 pounds. Consequently this atmospheric pressure plus the pressure of 10 pounds inside the cooker gives the necessary 25 pounds. But, at 6000 feet, atmospheric pressure has dropped to approximately 12 pounds. It is, therefore, necessary to have the gauge register 13 pounds pressure inside the cooker, instead of the 10 pounds.

Safety valve and petcock are sometimes separate and sometimes combined. In the separate safety valve a steel ball fits loosely into a socket, and a nickeled brass rod, wound with a coil spring, rests on the ball and is held in place by the outer housing of the valve, through which it passes. Excess pressure raises the ball, causing the spring to contract, and permits some of the steam to escape. It is most important to keep the ball and ball seat clean; they should be wiped dry after use to prevent them from becoming sticky or rusty. It is well always to test the safety valve before starting to use the pressure cooker.

The double-duty valve has a beveled steel point which fits into the steam exhaust port. When functioning as a petcock, it is raised from the port; when a safety valve, it is lowered. The combination valve makes for simplicity of operation.

The separate petcock is a nickel-plated brass rod that screws into a collar in which there are one or two vents. When the rod is un-

screwed, air or steam may escape; when screwed down, the vents are closed. Nickel-plated brass is used for all these parts because it will not rust. Rusting might easily weaken some part and impair the action of the cooker.

The cover is fastened to the cooker by some type of clamping device. One method is by separate clamps, four to seven in number, at regular intervals around the cooker. Part of the clamp may be on the body of the cooker, the other part on the cover, or the whole clamp may be on the cover. When the clamps are entirely on the cover they do not become hot before the cover is put on, and the kettle part of the cooker is more easily cleaned. When there is an arrow or other mark on the cooker kettle and another one on the cover, to indicate where the two should come together, be sure that one is directly above the other before starting to fasten the clamps. If the clamps are tightened in pairs on opposite sides of the cooker, the pressure will be kept the same all the way around. Bolts and nuts used in the clamps are usually of brass.

Some pressure cookers have a single clamping band, either across the top or around the cover, which is tightened with a thumb screw. This increases the ease of handling the cooker but makes an extra piece to store. The "bayonet" type of closure is widely used on new models. In this type a series of projections on the edge of the cover slides into grooves on the rim of the pot and locks the cover into position.

When the pressure cooker is ready for use, add water below the trivet, set in the cans or jars of food, adjust and clamp on the cover. When the safety valve and petcock are separate, screw the safety valve down tightly but leave the petcock open. If the two are combined, adjust the valve to permit the steam to escape. Allow the steam to issue from the vents 7 to 10 minutes. A series of tests was made in the foods and nutrition department at Iowa State College on a 25-quart cooker to determine how nearly the internal temperature of the pressure cooker checked with that indicated on the gauge, when the petcock (1) was closed at the appearance of steam, (2) was left open for 3 minutes after steam began to escape, and (3) was left open 7 to 10 minutes after steam appeared. When the petcock was closed 5 to 7 minutes after steam began to escape, the temperature inside the pressure cooker was 4° F. lower than the indicated internal temperature; when it was closed 3 minutes after steam appeared, the inside temperature was 8° F. lower; but when the petcock was closed as soon as steam appeared, the inside temperature was 39° F. lower

than indicated. If the pressure cooker is to give the desired high temperatures, it is essential that the petcock be left open sufficiently long to allow all air to escape.

When the necessary pressure is indicated on the dial, the pressure may be held constant by regulating the heat. A fluctuating pressure should be avoided since it tends to draw juices from the jars. Pressure cookers may be used over any source of heat: gas, kerosene, electricity, gasoline, wood, or coal.

When the processing period is over, it is usually preferable to turn off the heat and allow the pointer on the dial to come back to zero before opening the cooker; the cooling may be hastened by wrapping cold wet cloths around the pot. This rule must always be followed in glass canning; if the pressure is reduced immediately by opening the petcock, liquid will be withdrawn from the jars. When canning in tin cans no larger than No. 2, the pressure should be reduced quickly by opening the petcock and the tins may be put into cold water.

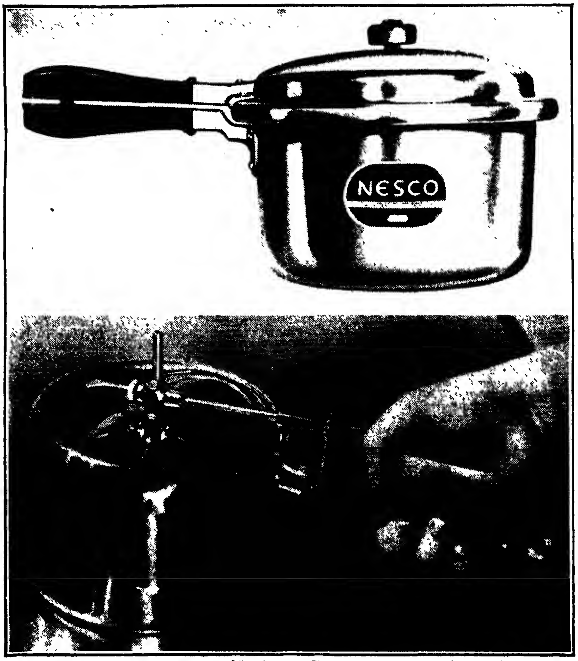
In either case, before opening the cooker, open the petcock gradually, until the steam has escaped and normal pressure has been restored inside. Then the lid may be unclamped and lifted off. Lift the cover toward the operator to direct steam away from the face.

The kettle part of the pressure cooker is washed in the same way as any cooking utensil. The lid with the gauge should not be put into water but should be wiped out. The lid should be stored separately from the kettle, to allow it to air.

The manufacturer of any pressure cooker will send complete directions for its use. Cookers come in various sizes. One firm manufactures them in 7-, 11-, and 18-quart sizes; another firm, 10-, 12-, 18-, and 25-quart sizes.

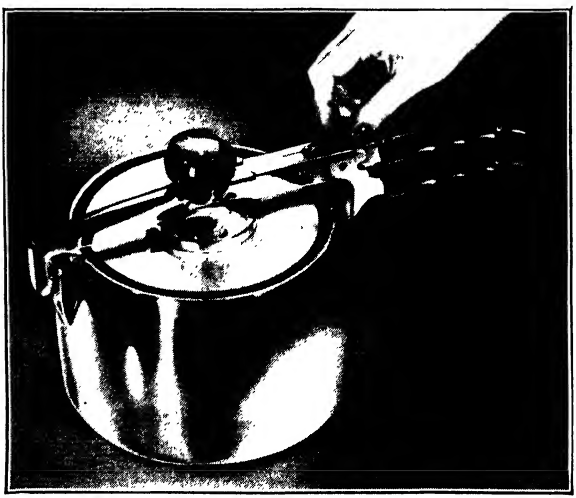
Pressure saucepans

Except for canning operations, the pressure pan has now largely replaced the larger cooker. There are two general types (Fig. 7.): one type has a flexible cover that is slipped under the rim of the pan, pressed or flexed into position, and held there by a hook attachment on the handle; the other has an outside cover that slides into grooves on the rim of the pan and locks into position. Arrows on cover and pan indicate open and closed positions. A rubber gasket aids in obtaining a tight seal. One model has a hook on the edge of the cover that fits over a projection on the pot rim. A locking device on the handle completes the seal. (Fig. 8.) At first the cover does



National Enameling and Stamping Co.
Vischer Products Co.

FIG. 7. Pressure saucepans.

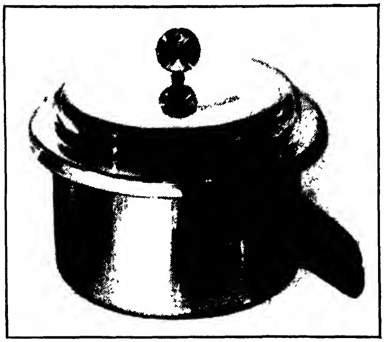


General Mills

FIG. 8. Pressure pan with special clamping and steam-release devices.

not touch the rim of the pan, but, as the steam rises, the heat causes the cover to flex, curving the edge downward, so that it is sealed tightly against the pan rim.

A vent tube allows steam to escape. The pressure is registered by a weight placed over the vent or by a separate gauge. In some models the weight is locked into position so that it cannot blow off. The weight may also control the pressure. One cooker has a scale beam on the cover with an adjustable weight to hold the pressure constant. Only one pressure, usually 15 pounds, may be indicated; in some cookers, however, 5, 10, and 15 pounds pressure or an even greater variety may be obtained. (Fig. 9.)



Mirro Aluminum, Aluminum Goods Mfg. Co.

FIG. 9. Pressure weight indicates three pressures.

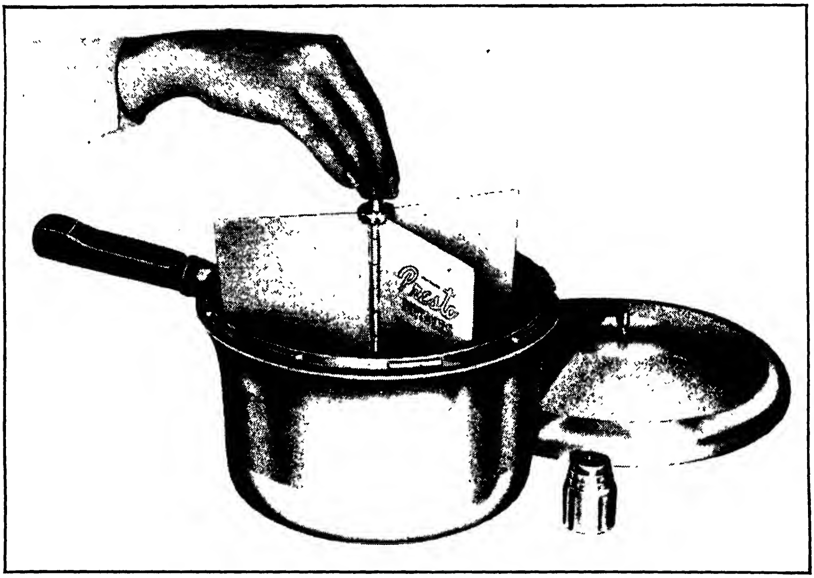
The control weight jiggles when the desired pressure is reached, and the pressure is maintained by adjusting the heat so that the weight jiggles only a few times a minute and steam escapes slowly. When the control is the knob or lever type, the pressure is indicated by a hum or hissing sound. A safety device in the cover, a plug of fusible alloy or of synthetic rubber, automatically releases too great excess pressure or reacts if the kettle goes dry.

Pressure pans are usually saucepans with a single handle, but a few manufacturers make pots with a handle on either side. One company produces both kinds, a saucepan and a casserole, each of them with a second cover so that they may be used for pressure cooking or not, as desired. A divider that is available for use with some pans makes possible the cooking of two or three food products at the same time. The divider leaves are held firmly in position by attachment to the cooking rack. (Fig. 10.) Most cookers have a domed cover which increases their capacity.

Pressure saucepans are made of aluminum, cast or pressed, and of stainless steel, with or without the copper bottom. Handles and knobs are usually of plastic materials. Most of them carry the Underwriters' Laboratory Seal, and only those so marked should be purchased. They vary in size from 2- to 7-quart capacity, depending upon the manufacturer. Some companies make only one size; others,

two or more. In cleaning, all parts may be immersed in water, an advantage not possessed by the larger pressure cooker.

The pressure pan is widely used in meal preparation, since it greatly shortens many cooking processes. Colors, even green, are not destroyed because of the brief steaming period. This method also tends to preserve vitamins and minerals. The absence of air prevents oxidation of sensitive vitamins, and the small amount of water needed,



National Pressure Cooker Co.

FIG. 10. A divider to separate foods in the pressure pan.

usually less than a third of that required by ordinary cooking methods, prevents the dissolving of soluble nutrients. Directions must be carefully followed, however. Overcooking, even for a very brief time, may result in a mushy unpalatable product. Cooking in the pressure saucepan, therefore, requires somewhat more attention than cooking by the usual methods. Cooking time is counted from the moment the desired pressure is reached.

At the end of the cooking process the pressure is brought back to normal before opening the pan. The usual method is to run cold water over the pan, but several cookers have special devices to release the steam. When cooking meats and dried vegetables it is desirable to allow the pressure to come back to normal slowly. In any case it is essential to have the pressure reduced before removing

the cover; otherwise a serious accident may result. Monroe notes that certain foods such as thick soups, cereals, stews, and dried beans, in fact any foods that tend to thicken the cooking water, lose pressure slowly. As a result the thickened mass may hold sufficient pressure, even though none is indicated, to blow some of the food from the pan when the cover is removed. When cooking such foods Monroe recommends that the pressure pan be placed in a second pan of cold water to cool the food at the bottom of the cooker adequately. The flexible cover cannot be removed if there is any pressure inside the pan, a point in favor of this type.

It is important to keep the air vent clean. Any obstruction in it may cause the pressure to build up without a means for the steam to escape. Some manufacturers' directions state that the cooker should not be used for cooking stews, applesauce, rice, and similar foods that tend to foam and hence boil up into the vent.

The rubber gasket also should be kept clean, free from food and grease. When it becomes worn and no longer makes a tight seal, it should be replaced with a new one.

The cooker sometimes becomes discolored from minerals in the water or in the food itself. Such stains may be removed by boiling a weak solution of vinegar or cream of tartar in the pan and by scouring it with fine steel wool.

Materials for oven utensils

The same materials are used for oven utensils as for surface kettles and pans and in addition tinned steel or iron, earthenware, and heat-proof china. All materials do not have the same conductivity, so choice will be influenced by the length of the baking operation. Lightweight materials that heat quickly are desirable for short-time use, whereas the heavier weights, requiring a longer heating period but retaining heat well, are better for long processes.

Roasting pans

The roasting of meat in an uncovered pan is now usually recommended. Lowe found that cooking losses are less and meat is more palatable when the uncovered roaster is used.

Roasters are oval, rectangular, or round, and of enameledware, aluminum, iron, or steel. As a result of extensive tests, the American Gas Association reports that a dark- or glass-surfaced utensil with a large bottom area is preferable to a small, polished pan. A roasting pan

with sides approximately 1 inch high, and with a smooth surface, rounded corners, and as few grooves as possible is easiest to clean. Steel wool is helpful in removing burned-on fat.

Boneless roasts should be placed on a trivet to keep the meat out of extracted fat and juices and to prevent sticking. Some roasters have perforated trays to hold the meat.

Cake and muffin pans

Cake pans may be oblong, square, or round; deep or shallow. They are of aluminum, oven glass, tinned steel, Russian iron, or enameledware. Russian iron is iron with an oxide coating that retards rusting. Rounded corners and edges make for ease of cleaning. When the pan has a separate bottom, the inset should fit tightly to prevent batter from dripping.

A food product is affected by the kind of pan in which it is baked. In the household equipment laboratory loaf cakes were baked in aluminum, tin, Pyrex, and enameledware pans of the same shape and size, in the same position in the oven, and at the same temperature. The cake in the enameledware pan baked most rapidly and had a thick, fairly hard, dark crust on sides and bottom. It rose unevenly with a tendency to be high in the middle. Cake baked in tinned steel and aluminum were of desirable shape and had a tender, light-brown crust. For equal results, cake must be baked a few minutes longer in an aluminum pan than in tin. The cake in the glass pan was slightly darker than in the tin but was of good shape. These same results were obtained in repeated experiments in both gas and electric ovens, indicating that the baking period must be shortened if enameledware is used and lengthened for aluminum, or the cake in the enameledware may be baked at a lower temperature. When the aluminum pan is new or highly polished, it will reflect the radiant heat and a longer baking time will be needed.

The shape and size of the pan affect the product, too. Sharp pan corners tend to cause the cake to be browner at the corners than on the rest of the surface. A shallow pan usually gives a coarser cake than a deep one. Too large a pan may allow the batter to be spread so thin that excessive browning results.

Muffin pans are made of the same materials as cake pans, with similar baking results. Muffin pans at best are hard to clean. Pans with few joints and creases should be selected. Individual muffin cups have certain advantages in this respect.

Baking sheets

Aluminum, sheet iron, and tinned steel are the materials commonly used for baking sheets. A pebbled surface on the tinned sheet prevents sticking and helps to decrease any tendency to warp.

Cookies and cream puffs rise and brown more evenly when cooked on baking sheets rather than in pans. Sides on pans baffle the heat, and the bottom of the cookie or puff becomes too brown before the top is the desired color. This is especially true if the sides are deep. Layer-cake pans may be used successfully because the sides are low. They are recommended for baking-powder biscuits.

Hart reports a carefully controlled test in which refrigerator cookies of uniform thickness were baked for 8 minutes in a 375° F. oven on baking sheets of enameledware, sheet iron, tinned steel, aluminum, and glass. She found that the most nearly standard cookies were baked on the aluminum sheet, those on sheet iron and tinned steel ranking second. The cookies on the enameledware sheet were burned and those on the glass not browned at all, again indicating the necessity of varying the baking period with the material of the pan.

Baking dishes

Any of the materials used for other types of pans may also be used for baking dishes, but covered casseroles and many uncovered bakers

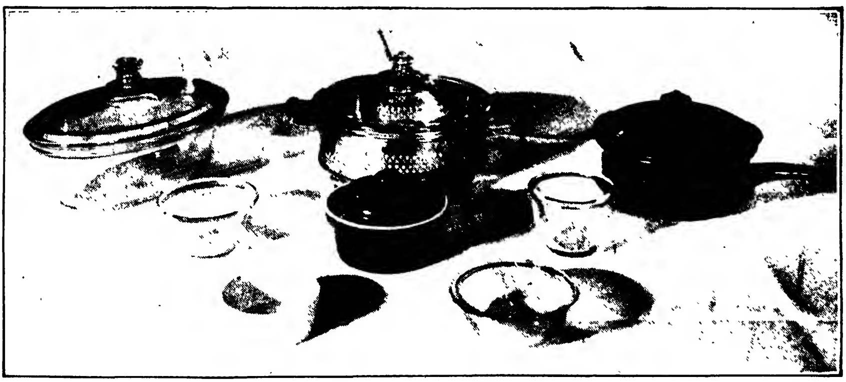


Fig. 11. Casseroles and ramekins.

are frequently of heatproof glass, earthenware, or china. Heat-resistant glass absorbs radiant energy extremely well and is especially desirable for oven use. Casseroles come in graduated sizes, the smaller individual ones being known as ramekins. (Fig. 11.) Heatproof china may be plain or have a conventional design or a splash

of bright-hued flowers, as the purchaser chooses. Common bean pots make excellent casseroles, suited to a variety of uses. Shallow broad bakers give a large surface for browning.

Foods baked in dishes of these wares may be served directly on the table, thus eliminating the cost of an extra container and saving extra dishwashing and storage space. Often the cover is flat on top so that it may be used separately for a pie plate or an "au gratin" dish. A dish with handles is more easily removed from a hot oven, but the handles take up a little more space. Casseroles and bakers may be set into stands of nickel or chromium, to increase ease of handling and to protect the table from the heat.

In selecting a casserole, be sure that the surface is non-absorbent and free from tiny cracks and flaws which impair its smoothness and make cleaning difficult. Glass will crack if subjected to sudden variations in temperature and should be allowed to cool before cold water is poured into it. Brushing the surface with an unsalted fat before use and soaking before washing minimizes the task of removing remnants of food.

Casseroles should not be used for surface cookery.

Accessory equipment

Measuring cups. Measuring cups are of tin, plastic materials, aluminum, or heatproof glass, the last two materials being preferable. (Fig. 12.)

Measuring cups of aluminum should be sufficiently heavy to hold their shape without denting or bending. The handle should be welded to the cup or carefully riveted, so that it will not come loose, and should be large enough to allow the use of a holder when hot liquids are measured. A lip on the side helps in pouring. A distinct groove between the bottom and sides, and deep-cut graduations with sharp edges, are to be avoided because of the difficulty of cleaning. Tin cups usually have deep indentations and also have a tendency to rust.

Glass measuring cups are usually smooth on the inside with the graduations marked on the outside surface only. Cups with red capacity marks are especially easy to read.

Plastic materials for measuring cups are light in weight and easy to handle because of their resistance to heat. They may be purchased in a number of attractive colors to fit into the kitchen color scheme. They tend, however, to be somewhat brittle and may crack or shatter

under a blow. They may warp if washed in very hot water such as is recommended for the electric dishwasher.

There are three kinds of measuring cups: those which measure a cup when full, those which measure a cup about a quarter of an inch below the rim, and single-capacity cups, four in a set, the full cup, half, quarter, and third cup. (Fig. 12.) The first kind is best for

Good Housekeeping Institute

FIG. 12. Measuring cups and spoons.

measuring dry materials, the second for liquids. The single-capacity types may be used for either, but are especially accurate for dry ingredients. The graduated cup is marked to indicate $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ cup on one side and $\frac{1}{3}$ and $\frac{2}{3}$ cup on the other. A few are marked in ounces. The transparency of glass is an aid in determining whether the substance measured is even with the graduation.

The Code of Specifications for household measuring cups, formulated by the National Bureau of Standards, states that the standard measuring cup shall have a capacity of $\frac{1}{2}$ liquid pint (8 fluid ounces) or 16 tablespoons. The code also specifies that the top diameter of the 1-cup measuring cup must not exceed 3 inches; the word "cup" must be marked on the side to indicate the capacity; if a pouring lip is present, it must not interfere with filling the cup to the edge or

graduation mark when the cup is on a level surface; and all graduated cups must have handles.

Measuring spoons. Although other types are found on the market, measuring spoons usually come in a cluster of three or four. The cluster may have a teaspoon, half teaspoon, and quarter teaspoon, or these three and in addition a tablespoon. (Fig. 12.) Since there are 16 level tablespoons to a cup, the standard tablespoon is $\frac{1}{16}$ standard cup. The teaspoon by common usage is $\frac{1}{3}$ tablespoon. Measuring spoons are made of aluminum, plastics, or stainless steel. Care must be taken not to bend the handle of the aluminum spoon where it joins the bowl, for aluminum is brittle and cannot be soldered. Since the war some measuring equipment has not conformed to the code and should be checked before purchase.

Sifters. Depending upon one's choice of a sifter, flour and other ingredients may be sifted once, twice, or even more times in a single operation. The wire screen may be coarse or fine. A fine screen sifts more thoroughly.

The sifter is held in one hand and the sifting mechanism operated by the other, or, in certain constructions, one hand may both hold and sift either by shaking the sifter from side to side or by moving a flat metal ring, attached to a spring in the handle, across the screen. Such a method is very efficient, for the other hand may stir the mixture at the same time.

Sifters are commonly of tin. They should be sturdy in construction with substantial, securely fastened handles, if handles are present. Sifters should be washed in warm soapy water, rinsed in hot water, shaken, wiped as dry as possible, and left in a warm place until thoroughly dry, to prevent rusting.

Strainers. Wire strainers may be used for sifting, as well as for the numerous other operations for which they are intended. The wire screen must be carefully fastened to the solid metal edge, and two or three pieces of heavy metal ribbon beneath the bowl will serve as extra support and tend to increase the life of the strainer.

A type of strainer called a colander, made of tin, aluminum, or graniteware, has perforated sides and bottom. The holes are drilled, and are larger than the individual meshes of a wire screen.

Metal sieves, or fruit and vegetable presses, of tin or aluminum, also have drilled holes. The holes are smaller than in the colander and much closer together. The tin sieve is somewhat more efficient than the aluminum because tin can be used in a thinner sheet and the edges of the holes are very sharp. The sieves are often conical in

shape and are used with a conical wooden mallet which is revolved against the inner surface to force the product through in a finely divided state. Such an appliance is used for making purées or preparing fruit for whips.

One press on the market is of steel. The perforated seamless bowl is spherical, and a revolving spiral pressure blade with beveled edges presses the food through the holes. A metal scraper, which may be attached below the bowl, scrapes off the food.

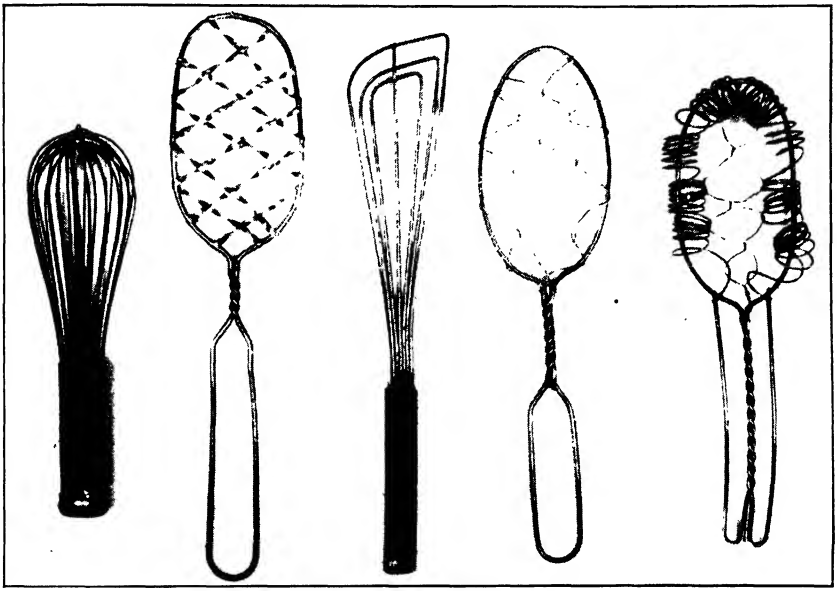


FIG. 13. A variety of whisk beaters.

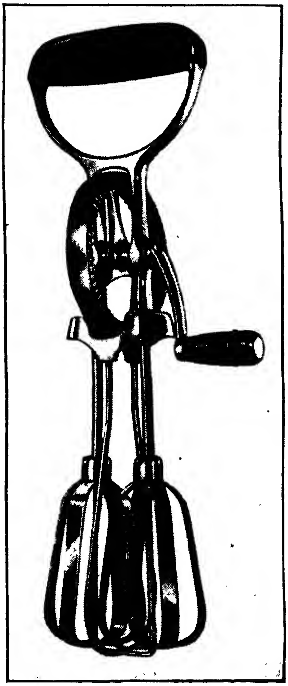
Beaters. Few pieces of small equipment have more constant and varied use than beaters. They develop a fine texture, mix ingredients, clump fat in whipping cream, and incorporate air.

The two types of beaters most commonly found on the market are the whisk and wheel or rotary.

The whisk is effective in incorporating large amounts of air and gives maximum volume though a somewhat coarse texture. (Fig. 13.) It may be made of many fine wires, each wire forming a long oval, and all the wires brought together at the top to make a handle; or it may take any one of many spoon shapes. The outer edge of the spoon is of fairly heavy wire, with a mesh center of fine wires or flat metal ribbon, looped, interlaced, twisted, or coiled. One model has

a mesh stamped out of a flat sheet of metal. Fine wires give greatest volume. Wires should be fastened smoothly and securely to the frame to make cleaning easier and to increase the durability of the beater.

The handle may be an extension of the frame, or the ends of the frame may be fastened into a wooden handle. The ends must be firmly fixed in the wooden handle or they will pull out. All handles should be shaped to fit the hand comfortably. Whisk beaters require a good deal of energy, for all the work is done by the operator.



Ecko Products Co.

FIG. 14. Rotary beater. Note simplified construction that increases ease of cleaning.

Wheel or rotary beaters are often called Dover beaters because the first one, of cast iron with two agitators, was made by a Mr. Dover more than eighty years ago. At the present time a number of different companies manufacture a wheel beater of steel with four circular or elliptical agitators which revolve in a vertical plane. (Fig. 14.) Other beaters have two circles, and occasionally five circles are found, one being stationary. Four agitators produce greater volume than two, for they throw the food over a greater space and incorporate more air. If the blades are held rigidly in position, the volume seems to be increased. In some beaters rigidity is procured by metal bands around each group of blades. To be most efficient the blades should have thin cutting edges.

The agitators are fastened around a support of heavy metal wire, which carries the small pinions. The wire is riveted or welded to the main shaft, to which the large cog wheel and handle are attached. The thickness of the wire determines how closely the beater will fit to the bottom of the container, and the more closely it fits, the more effective, since all food is brought into better contact with the blades.

The advantage of the beater depends in part upon the ratio of the gears in the pinions to the gears in the drive wheel. A ratio of 1 to 4 and 1 to 5 is most commonly found; i.e., the larger wheel makes one

revolution while the beating circles make four or five, or, in other words, the beater itself will do four or five times as much work as the housewife. A central drive wheel makes better contact with the

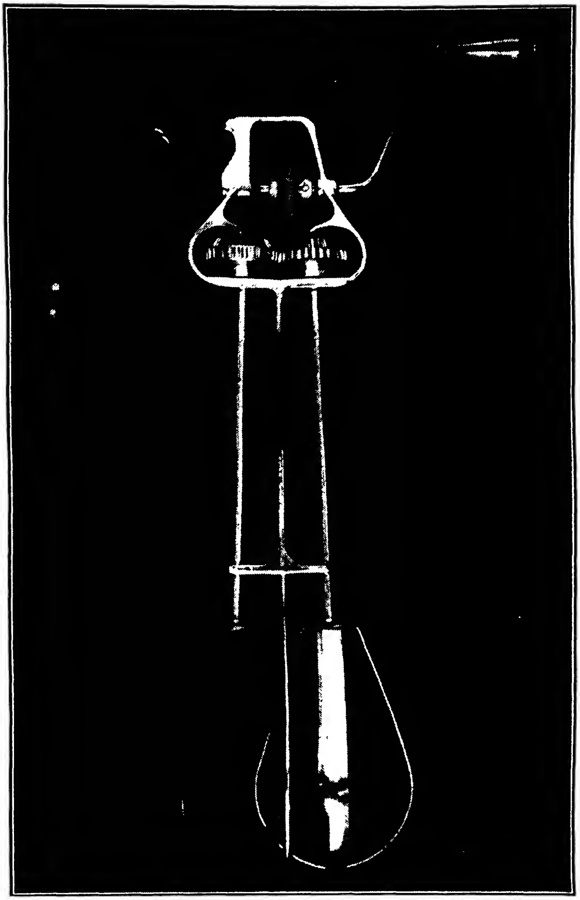


FIG. 15. One pinion wheel has twice as many gears as the other.

pinions, supports on either side preventing it from running "out of mesh." The wheel beater produces the finest texture.

The beater illustrated in Fig. 15 has twice the number of gears in one of the pinions as in the other, giving a ratio of 1 to 2 and 1 to 4 respectively. By a slight manipulation the central drive wheel is brought into contact with either pinion. The slower 1 to 2 speed may be used for beating liquids which tend to spatter or for thick

mixtures. Note the downward sloping handle which keeps the shoulder in a normal position and eliminates muscular fatigue.

A third beater, the turbine, is less widely known and used. Some appliances made specially for whipping cream include this type. The turbine has a slightly cupped, slotted, circular metal disk fastened to the end of a central shaft which carries a pinion and is attached to a drive wheel. It is manipulated in the same manner as the Dover-type beater, and the general rules of construction are the same for both. The slotted disk revolves in a horizontal plane and is effective in general mixing, but there is no lifting action, so that the volume obtained is smaller than with the whisk and rotary.

Handles are of various designs. A handle should fit the hand, preferably projecting slightly beyond the hand to prevent cramping the muscles. The shank should be sufficiently long to eliminate any danger of contact with the cogs. The same thing is true of the small handle on the drive wheel, which should be easy to grasp and long enough to keep the hand from the gears.

All beaters should be durable in construction, with a smooth, rust-resisting finish. Agitators of stainless steel, or steel which has been electroplated with copper and then with nickel, have proved most satisfactory. Gears should mesh accurately. Ball bearings increase the ease of manipulation. Lightweight beaters, if they are at the same time durable and efficient, are to be preferred. Thin blades and wires cut the mixture into more minute particles than thick blades and heavy wires and consequently give greater volume and finer texture. For efficiency, any beater must fit closely to the bottom of the container so that it will pick up all the material and beat and mix it thoroughly.

Since the beater is always used with some kind of platter or bowl, it may be well to consider types of containers at this time. The efficiency of a beater often depends upon the shape of the bowl.

Bowls. Broad shallow bowls or platters are used with whisk beaters, narrow deep bowls with the rotary or turbine. All bowls should have a smooth, rounded interior surface with no creases to retain some of the mixture.

Bowls are made of enameledware, aluminum, earthenware, glass, and china; occasionally, also, of stainless steel and wood. Most metal and enameledware bowls are light in weight, a valuable characteristic for many uses, but they tend to slide around and have to be held in position when used with a beater, and this is difficult when both hands are needed for the operation. Bowls of these materials may

be easily scratched, and they may discolor; when they are used for mixing, the stirring should be done with a wooden spoon. Many stainless steel bowls are heavy, and they are not scratched during ordinary use. A new aluminum bowl has a stain-resisting finish that will not smudge. The use of chipped enameledware bowls should be avoided since a slight blow of the spoon or beater may cause additional pieces of enamel to scale off into the food.

Bowls of glass, china, or earthenware are heavier and scratch and mar much less readily. Sometimes earthenware bowls have a ridged outer surface by which they may be held firmly. It is good practice, however, to let the bowl rest on a table of the proper height instead of using energy to hold it.

At the present time bowls may often be purchased in sets of three or five and in a variety of attractive hues. Such sets offer a diversity of sizes, suited to many uses, and add a bright bit of color to the kitchen.

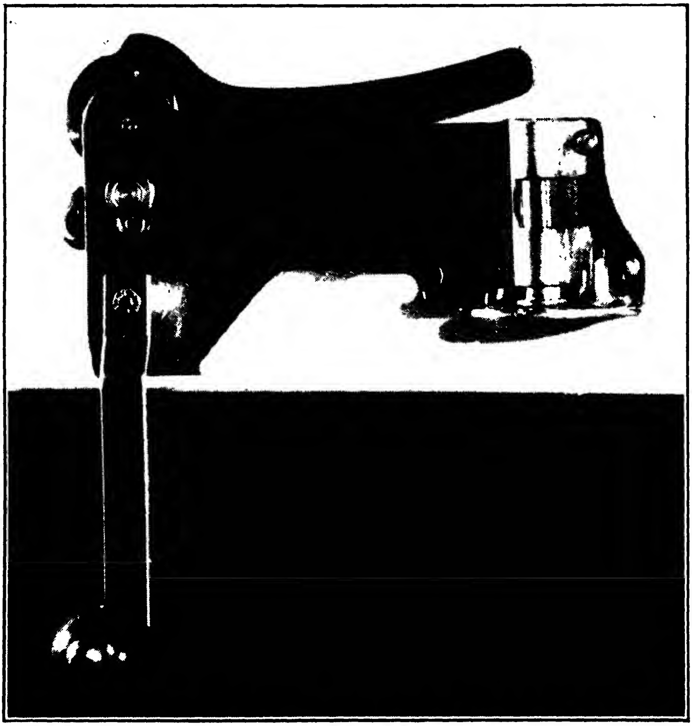
Can openers. Small accessory equipment is too frequently purchased at the dime store. It looks and behaves well when new but does not stand up under continuous hard service. The can opener is no exception. Most can openers that require two hands for manipulation are inefficient. They take a lot of energy to use, and they leave a jagged, hazardous edge on the can. A good can opener should remove the cover from a round, square, or oval can with the minimum of effort and should leave a smooth even edge. Openers that fasten to the wall or table edge usually do this. The can to be opened is held mechanically between two wheels, one with a knife-blade rim; or, in another model, the can rests on a metal shelf and a sharp knife point is pressed from above into the edge of the cover. In either type the cutting is done by turning a crank, which takes only a moderate amount of energy, uses only one hand, and cuts the cover cleanly from the top of the can. Usually only the flat metal support is permanently fastened to the wall; the rest of the can opener may be removed and placed in a drawer. One can opener is pivoted and will swing back and lie flat against the wall when not in use. (Fig. 16.) The cutting blade of the can opener should be sharpened regularly.

Cutlery. Knives, forks, spoons, and spatulas of good quality are a worth-while investment.

A study of the time taken and motions made in preparing three meals a day for ten days disclosed the interesting fact that the housewife performs some task with a knife on an average of 129 times a day. It may well be said that "the use of the household and kitchen

knife in its varied and improved forms marks the dividing line between savagery and civilization; and the more skilled a nation becomes in the preparation of foods, the more attention it pays to the design and workmanship of its cutlery." [1]

Stainless steel has eliminated the drudgery of scouring which once followed every meal and so appeals to the homemaker, but stainless



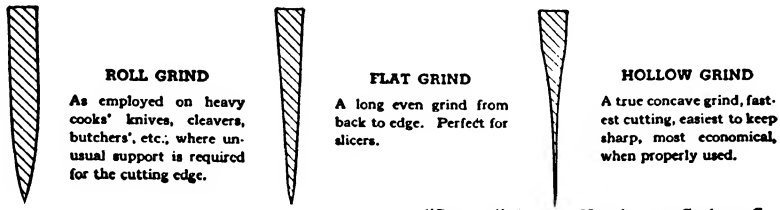
Steel Products Mfg. Co.

FIG. 16. A can opener that swings back against the wall.

steel knives are not recommended for satisfactory service. The best knives are of high-carbon steel or of vanadium steel. A good steel knife of lasting quality must have a high carbon content, 100 to 125 point. A point is 0.01 per cent. In making stainless steel part of the carbon is replaced by chromium, and this reduction in percentage of carbon lessens the efficiency. Vanadium steel knives have a non-corrosive finish. Some carbon-steel knives are chromium plated with the edge left uncovered for more satisfactory sharpening. Method of tempering and grinding also affects the edge.

[1] *The Most Important Tool in Your Kitchen,* Harrison Cutlery Co., p. 3.

Knives are forged, beveled, or stamped. When hand-forged, the heated steel is hammered into shape by hand. Such knives are very expensive. A less costly method is to exert pressure on the heated steel with a drop hammer which does not change the knife's outward



"Dexter," Russell-Harrington Cutlery Co.

FIG. 17. Cross sections of knife edges, showing types suited to different purposes.

appearance. Beveled knives are formed from a steel bar which is thick in the center and tapers toward each edge. Two blades back to back are cut at one time. Stamped knives are cut from metal sheets and ground to an edge. The forged knife will give longer service and take a superior cutting edge because forging develops a finer grain in the steel. After forging, the blade is hardened, tempered, and ground—frequently under water to prevent drawing the temper. Hollow-ground blades, in which the sides of the blade are concaved like an old-fashioned straight razor, are the best. (Fig. 17.)

A knife should have proper "spring" and good balance; i.e., weights of handle and blade are adjusted so that the knife is easily manipulated without strain on the muscles. A blade with spring is ground tapering from handle to point. When such a blade is bent, about one-third of it next to the handle remains rigid, the other two-thirds to the point are flexible enough to form a slight curve. (Fig. 18.) If of steel it will usually spring back into position; the iron knife will remain slightly out of line. A cross section of the blade, cut perpendicular to its length, should be a flat-sided wedge. This shape is most easily ground to a desirable edge.

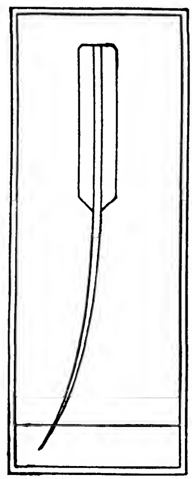
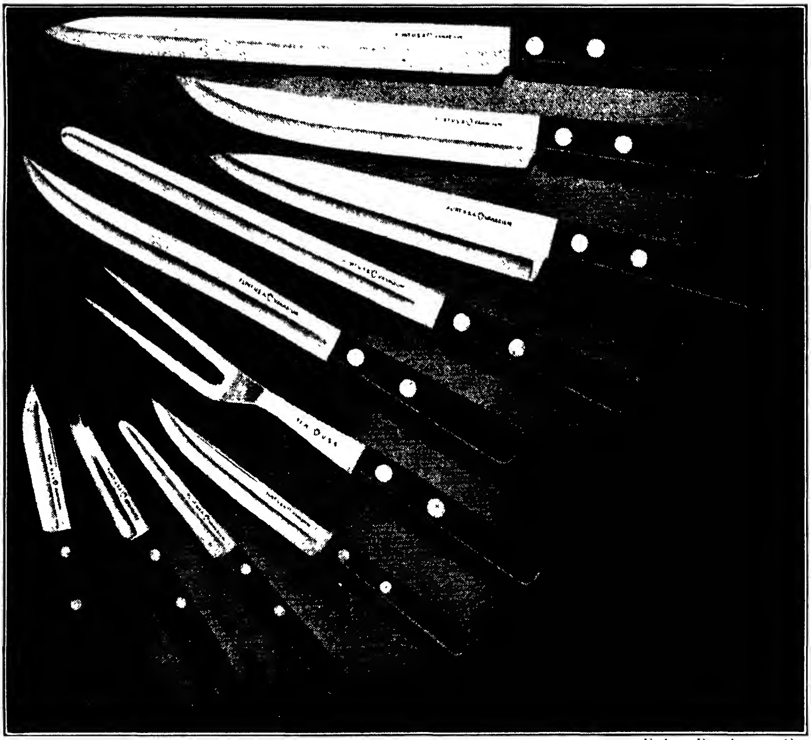


FIG. 18. A tapering blade has "spring."

Good knives often are recognized by the manner in which the blade is fastened into the handle. In a cheaply constructed knife, the shank of the blade, tang as it is called, is narrowed to a point,

which is pushed into the handle and held there by a small nail or brad or sometimes merely by a metal collar. The nail or collar may work loose if the wood becomes softened in water, and the blade may pull out.

A better method is to have the tang extend the entire length or at least half the length of the handle and be fastened in by two



Ecko Products Co.

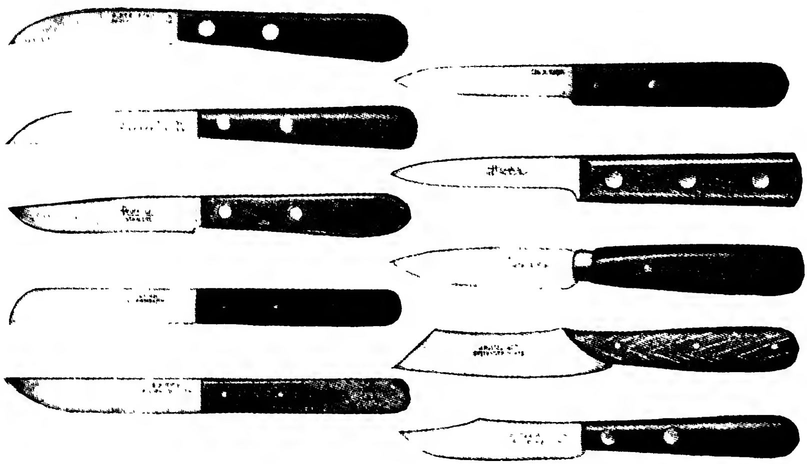
Fig. 19. Hollow-ground knives of vanadium steel. The hardwood handles are secured by compression rivets to prevent loosening.

or three good-sized rivets. The wood is more likely to split when small rivets are used. (Fig. 19.) Some knives have the join between handle and blade protected by a metal shoulder. In the more expensive knives this shoulder is forged as part of the blade.

Handles are usually made of wood or a plastic material. When plastic is used the shank is molded into it by heat and forms with it a solid piece. These handles are very strong and durable, there are no cracks to collect dirt, and the material is practically moisture-

proof, but they will break with rough usage. Some cutlery manufacturers use rosewood for handles. It is a very hard, close-grained wood that is resistant to moisture and will not stain or warp.

Knives are classified according to the shape and length of the blade. At least four different kinds find a use in most homes. The paring



Russell-Harrington Cutlery Co.

Fig. 20. Paring knives are of various shapes; modifications of the three fundamental types—sharp, spear, or clip point.

knife has a short blade, which gives leverage without undue strain on the finger muscles. Blades of paring knives are of three forms, with a sharp, a clip, or a spear point. (Fig. 20.)

The utility knife is of medium size and may have a straight or curved cutting edge. It has many uses: cutting up large vegetables, trimming meat, slicing cold chicken, cleaning fish, in fact almost any kind of food preparation.

Russell-Harrington Cutlery Co.

Fig. 21. Carving knife.

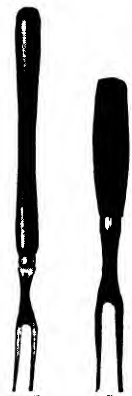
Although the carving knife is used principally at the dining room table, it is often needed in the kitchen. It has a fairly long sturdy blade, not too pliable, that it may cut hot, yielding meats with ease and sever joints. The point has a long, rather thin curve, to assist in getting around the bones. (Fig. 21.)

The fourth member of the quartette is the slicing knife. (Fig. 22.) This knife has a long flexible blade, tapering slightly at the point, and will give the thinnest slices of cold meat, bread, or cake.

To this list, if desired, may be added the butcher knife with its thick, heavy, curved blade for strength; the grapefruit knife, curved and serrated, to cut the sections of the fruit from the rind and the enclosing membranes (Fig. 19); and the French cook knife, with its straight edge and firm but tapering point. The handle of the French knife is placed in line with the back of the blade, that the hand may not interfere when the knife is used for quantity chopping of nuts and small fruits and vegetables. (Fig. 23.)

FIG. 22. Slicer.

FIG. 23. French cook knife.



Russell-Harrington Cutlery Co.

FIG. 24. Long- and short-handled 2-tine forks.

Another most useful and efficient knife is the serrated or scalloped-edged bread knife. The serrated edge has groups of fine ridges, running first in one direction and then in another, which are self-sharpening and always cut satisfactorily. Cutting bread dulls other knives rapidly. A blade should never be heated to aid in slicing, since this treatment destroys the temper of the steel. A knife should also not be used to cut metal, bone, paper, or string.

Transparent plastic knives are stainproof and are recommended for cutting thin slices of vegetables and fruits. They may have serrated edges like the bread knife.

Since good steel cannot be recognized at a glance, the purchaser should buy cutlery made by a reliable manufacturer. It is not so much the number of knives that the housewife has but rather the

careful selection of a knife to meet a definite need that will make her kitchen well equipped and her work easier.

All knives need to be sharpened. The knife sharpener may be two finely corrugated steel wheels or two wheels of emery or sandstone turned by a handle. Sandstone wheels are preferred to emery, because they do not wear away the steel as rapidly. If a knife becomes heated in the sharpening process, the temper may be drawn and the knife will lose its ability to keep an edge. Wetting the emery wheel or grindstone prevents this misfortune. Some can openers have as a second attachment a knife sharpener that may be put in place of the can opener. A tapering steel rod, fitted with a handle and held in the hand, is also used. All these sharpeners are effective for use with knives of low-carbon steel, but knives of high quality should be sharpened on a fine- or medium-grade oil stone. Hollow-ground blades should always be sharpened in this way, although a new knife sharpener of carbide—the hardest material made by man—is also recommended. A knife will remain sharp longer if food is cut on a wooden board. Do not leave knives in hot water.

Forks are of various sizes and have two, three, or four prongs, depending upon the use to which they are put. A long-handled fork is helpful when the kettle is deep or the food product large and heavy. Smaller forks are needed to hold meats when they are cut, and potatoes or other vegetables for skinning. The tines should be firm and sharp. Handles should have the same characteristics as handles on knives. (Fig. 24.)

Spoons for mixing, stirring, and serving are of aluminum, tin, graniteware, iron, inexpensive plated silver, or wood. Aluminum spoons are brittle and will not stand bending; most tin spoons rust easily; and all metal spoons scratch the container. Wooden spoons do not mar the bowl or kettle, are easy to hold, and do not become warm when hot mixtures are stirred, but they will warp and stain and will need to be replaced from time to time. One or two wooden spoons should find a place in every kitchen.

The spatula, first cousin to the artist's palette knife, with its flexible rounded blade of stainless steel riveted into a comfortably shaped handle, has many uses. (Fig. 25.) With it cups of dry ingredients are leveled off, egg whites are folded into mixtures, bowls are scraped clean of batter, and cakes are iced. If the blade is rigid close to the handle, but flexible for the rest of its length, it is more easily manipulated than when flexible for the entire length. The broad,

more rigid spatula may take the place of a pancake turner, remove cookies from the baking sheet, and perform other useful tasks. (Fig. 26.) Plastic spatulas are also available.

Kitchen shears are useful for many jobs—cutting marshmallows and dried fruits, snipping parsley, chives, and celery leaves, shredding chicken, separating bunches of grapes into serving portions, dividing bread dough into loaves and rolls.

Kitchen cutlery, knives especially, should be stored with care. Putting all kinds together in a drawer tends to nick the edges and break

Fig. 25. Spatula.

Russell-Harrington Cutlery Co.

Fig. 26. Broad spatula.

the points. Placing them in a wooden rack within the drawer or on the wall, or even hanging them on the wall, will prevent this damage. A new rack of permanently magnetized iron grasps cutlery or other metal utensils placed against it and is a real saver of time and motion.

Scrapers. Scrapers of rubber and plastic find extensive use in the home for removing final portions of frosting, whipped cream, melted chocolate, sauces, batters, and similar food products from bowls and pans. The scraper may be molded in one piece or have a separate handle of wood. Those with wooden handles are usually less durable since the handle tends to loosen from the scraper. The rubber scraper should be thoroughly washed in warm, soapy water immediately after use. Fats left on pure rubber, even for a short time, cause the rubber gradually to become spongy and sticky. Synthetic rubber is not affected by fats in this way.

Graters. Graters may be of various shapes: flat, cylindrical, square, or semicircular, but the shape is of secondary importance to the type of hole, which is punched or drilled.

Punched holes have rough uneven edges with four sharp points, and tend to give a mushy product of no distinct form and of compact volume. The drilled holes are round or crescent-shaped, and have a smooth, sharp edge that cuts the grated food into a definite shape, each small sliver separate from the piece next to it. The resulting volume is much larger than with the punched holes.

With either type, care must be taken to hold the product in such a way that the fingers do not come in contact with the sharp edges of the cutters. One safely manipulated grater, a rotary type, may be fastened to a shelf or table and looks a little like a hand-operated meat grinder. Surrounding the cylindrical cutting surface is an outer shell, with an opening on the top, through which food is held in contact with the revolving grater by means of a plunger. The cylinder is turned by a crank. If this grater is to work efficiently the cylinder must be close enough to the outer shell to leave no space in which the food may pack.

A flat model which grates, slices, or shreds has a protective device to keep the hand from the blades. Some graters and shredders which come in a set of various-sized cutters have an interchangeable safety guard.

Graters may be of aluminum, stainless steel, or plastic but are usually of tin. They should be sturdy in construction so that they will not bend out of shape. Drilled graters are more easily cleaned than the punched.

Slicers. Slicers are commonly of steel. A rotary slicer has two or three blades turned by a crank; a flat slicer has knife plates set in a wooden or metal frame. The crank-operated slicer is fastened to the table; the frame of the flat knife plate is supported by hand. Blades should be adjustable for different thicknesses of food and removable for sharpening. Slicers should be tested to determine how satisfactory a product they give, and whether they show a tendency to scatter the food. Some slicers have a device for protecting the hand.

Molds. Molds are most frequently used for "cold cookery," although muffins and fancy cakes are baked in certain types. They are made of glass, china, aluminum, enameledware, or tin, and should be of one piece, with all corners well rounded to permit easy cleaning.

Molds have many forms. Some are fluted; others have designs of flowers, fruits, animals, or special symbols used in fraternal and other organizations. All help to give a fancy shape to otherwise commonplace food.

Juice extractors. Fruit-juice extractors vary in size from small reamers of metal or glass with a slotted rim, placed over a cup or tumbler, to the large ones, patterned after the mechanical juice extractor, which are fastened to the table edge and turned by a hand crank. The housewife should select one which is suited to her needs, easy to operate, and easy to clean. The larger ones are efficient and surprisingly inexpensive.

Drip coffee pots

Non-electric drip coffee makers may, perhaps, be considered in a class by themselves. The coffee maker proper, of aluminum, silver-plated nickel, glass, or ceramic material, has a perforated bottom that fits into a vitrified china, glass, or aluminum pot. In making coffee a filter is sometimes placed over the perforated bottom, the finely ground coffee measured onto it, and a perforated cover set over the coffee. Boiling water poured into the top drips through the perforations onto the coffee, filters through it, extracting the constituents of the coffee, and flows into the pot. The manufacturers recommend a special fiber-silk filter, which holds back, with the grounds, the insoluble fats that injure the coffee flavor and are not easily digestible. In one model the filter disk and water spreader are of an odorless, tasteless plastic, and no filter paper is needed.

After the water has passed through the coffee, the drip section is removed and the coffee is served from the pot. Pots come in 2- to 9-cup sizes, and those of larger capacity will make smaller quantities satisfactorily.

Standards for judging the performance of coffee makers have been set up by the National Coffee Association. In addition to developing directions for the use of each kind of maker, the association has produced a standard coffee measure.

Limited space does not permit a discussion of the many perforated and lipped ladles and turners, cooking tongs, butter curlers, egg and tomato slicers, and the fancy cutters of all kinds and shapes for garnishes, cookies, and tiny cakes. The same suggestions with regard to fundamentals of selection apply to these smallest of appliances, used chiefly to gain artistic effects, as to the larger pieces of equipment.

Summary

1. A few utensils, each of which may be adapted to a number of cooking processes, are preferable to many utensils for individual uses.

2. A utensil should be sturdily constructed, of size, shape, weight, and material suited to the purpose for which it is to be used.
3. A utensil should have a smooth, seamless surface, with rounded corners free from rough edges. It should be well balanced.
4. Handles should fit the hand, be heat-resistant, and firmly fastened to the utensil with no unnecessary grooves.
5. Lips and spouts should be non-dripping.
6. Surface utensils should have flat bottoms and straight sides and should fit the range unit. Covers should be tight fitting.
7. Oven utensils should be of a size and shape to permit circulation of heat. A utensil suitable for table service saves initial cost, cleaning, and storage space.
8. Utensils used in the preparation of food should be accurate in measure, have sharp cutting edges, and should be adapted for use with one hand.
9. To be efficient, a utensil must accomplish in a moderate length of time and with the minimum of effort on the part of the homemaker the task for which it was made.
10. Utensils should be reasonably easy to clean.

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3

Fundamentals of Electricity

FROM THE EARLIEST DISCOVERY of electricity to the present day, attempts have been made to learn the nature of the electric current. Although the years of research have resulted only in a succession of theories regarding the elemental constitution of electricity, definite laws with regard to its action have been established. Electricity can be generated, directed, controlled, measured, and put to work.

ELECTRIC CURRENT

The flow of electricity in a definite direction through a substance is called an *electric current.* The unit for measuring the quantity of flow of an electric current is the *ampere.*

CONDUCTORS AND NON-CONDUCTORS

Certain metals transmit electricity readily and hence are called good conductors. Other materials such as glass, rubber, and wood are non-conductors or insulators. It is not possible to draw a definite dividing line between conductors and non-conductors, but, if materials are listed in the order of their ability to transmit an electric current, the materials at the top of the list are termed good conductors and those at the bottom insulators.

Aluminum and copper are the best conductors in commercial use; glass and porcelain are two of the most commonly used insulators. Mica, because of its heat-resisting qualities, is also used for an insulator in types of equipment where high heat is developed. Pure rubber is a good insulator but must be used where it is not subjected to heat or unfavorable weather conditions. Cotton, silk, asbestos, and rubber are the usual insulating materials used on portable conductors, such as cords for small appliances and lamps. Water and the ground are good conductors, and care must be taken not to come in contact with current-carrying wires when shoes are damp.

GENERATION OF ELECTRIC CURRENTS

To speak of the generation of an electric current is erroneous. What is generated is the force that starts the current moving in a

definite direction. In the early nineteenth century Michael Faraday found that, when a conductor was moved across a magnetic field, cutting the lines of force, an induced electric current flowed through the conductor. The rotating coil of copper wire that forms the conductor is known as the *armature*, and the magnetic field around the magnet as the *field*. The armature and field magnets together make a generator.

An electric generator is, in itself, a useless piece of machinery. It is only when some outside source of mechanical energy turns the armature that the generator produces the desired difference in electrical potential, or voltage. This outside energy may be from different sources such as water power, steam, a gas engine, or even wind. A generator is, therefore, a device for converting mechanical energy into electrical energy.

The difference in electrical potential which causes the current to flow is commonly known as *voltage*. The unit for measuring this difference in pressure is the *volt*.

Electric generators are used in two types of plants, central stations and home plants. Central stations generate large quantities of electric power and serve territories ranging in size from a small town to a radius of approximately 300 miles. They are classified as hydroelectric power plants or fuel power plants, depending upon the type of power used to drive the generator. Home plants develop small quantities of power and are classified as gas-engine plants or wind- or water-power plants.

Circuit

The path through which the current travels is known as an *electric circuit*. If the path is complete from one side of the generator to the other, the circuit is spoken of as a *closed circuit*. If a break is made in the circuit, either by a broken wire, a loose connection, or a switch, the circuit is known as an *open circuit* and the current ceases to flow.

Short circuit

Occasionally the insulation on conductors becomes worn so that the two lead wires accidentally come in contact with each other. When this condition occurs an intense current passes through this newly formed circuit, and its resistance is very low in comparison with the original circuit where the current passed through a lighting, heating, or motor-driven appliance. This condition, known as a *short circuit*, is usually accompanied by a momentary flash. Excessive cur-

rent in the circuit melts the link in a fuse or trips the switch in a circuit breaker, thus opening the circuit. Wires used in electric circuits have definite carrying capacities and if overloaded by the current from a short circuit may become so hot that they are a fire hazard. The fuse or circuit breaker is used, therefore, to eliminate this danger, and every circuit should be protected by such a safety device (p. 59). Short circuits occur most frequently in cords attached to small electrical appliances such as the hand iron, where there is excessive bending and twisting of the cord. Tap water is a good conductor of electricity, and a fabric-covered cord may develop a short circuit if it becomes damp.

Grounded circuits

The earth's crust is a good conductor of electricity. If a path of conductors is provided from an electric circuit to the earth's crust, the circuit is *grounded* and current flows to the earth. Grounded circuits occur frequently in appliances when the insulation of the circuit wire wears off and the wire comes in contact with the metal framework of the appliance, which in turn is in contact with materials reaching to the earth's crust. In the home the human body frequently completes the grounded circuit by touching the framework of the appliance.

Accidents from grounded circuits usually occur in laundries, where the person is standing on a wet floor, or in bathrooms, where he may come in contact with the metal plumbing. It is not safe to handle an electrical appliance attached to a live circuit when shoes or hands are wet.

Electric systems

The electric generator and the network of circuits which carry the current to distant points and through hundreds of homes are known as an electric system.

Kinds of current used

Electric generators make possible the generation of two kinds of current, known as *alternating* and *direct.*

As the armature revolves in the magnetic field, the voltage rises from zero to the maximum value, falls again to zero, reverses in direction, then continues to the negative maximum, and once more returns to zero. The direction of the current changes with the reverses in voltage and is known as alternating current. (Fig. 27.) The distance

from *a* to *a* is called a *cycle*. The number of cycles through which alternating current passes per second is known as its frequency. The frequencies of electric current commonly used in the home are 25 and 60 cycles. The current may be transmitted as an alternating current, or, by means of a commutator, the current may be taken off from the armature always in the same direction and will then be transmitted as a direct current. Direct current is used largely in industrial districts where high-horsepower motors are required. Certain commercial processes, such as refining of metals, electroplating, and charging of storage batteries, require direct current. Direct current is not

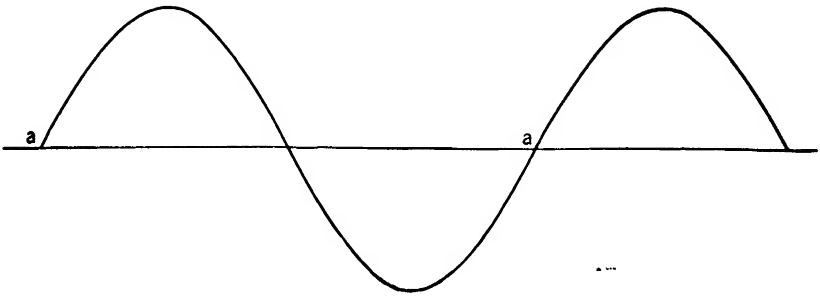


FIG. 27. The cycle of an alternating current.

transmitted long distances, as an economical method for changing its voltage has never been discovered. Alternating current is used for long-distance transmission.

TRANSFORMERS

In the early use of electricity it was soon discovered that high voltage was necessary if current was to be transmitted long distances and if losses in energy in transmission were to be kept at the minimum. It was also learned that different distances of transmission required different voltages and that high transmission voltages were not safe for use in the home. This led to the development of the transformer. A transformer consists of two insulated coils of wire wound on an iron core. As an alternating current is passed through one of these coils, called the primary coil, an electric current is induced in the other or secondary coil. If the secondary coil has a greater number of turns of wire than the primary, the voltage in the secondary will be larger and the transformer is called a *step-up* transformer. If the secondary coil has fewer turns of wire, a lower voltage is developed and the transformer is called a *step-down* transformer.

Voltages of electric systems

The voltage of the current in the transmission and distribution lines of an electric system depends largely on the distance the current is to travel. Approximately 1000 volts per mile are used for efficient transmission. Two voltages are used in the home. These vary with different power companies. When single-phase current is supplied, the lower voltage ranges from 110 volts to 125 volts and is used for lighting, small appliances, and household motors. The higher voltage, ranging from 220 volts to 250 volts, is used for household and farm appliances which use a large quantity of energy such as ranges, water heaters, and farm motors larger than ⅓ horsepower. Earlier systems supplied current at 110–220 volts, but it was soon found that higher voltages gave more efficient results. Standard voltages were increased to 115–230 volts, and today over 50 per cent of the current has a voltage of 120–250 volts. Where polyphase systems are used, the voltages supplied to the house are 120–208 volts.

Most small appliances are designed to be used on 115-volt current, because the specifications for construction of many small appliances were prepared by the National Electric Manufacturers at the time when 115–230 volts was recognized as standard voltage.

Electric-range specifications were adopted in 1939. They specify that the perferred standard rating shall be 115–120/230–240 volts with the elements designed for 118–236 voltage.[1]

Transmission and distribution

The discovery of the alternating current and the transformer has made possible the transmission of high-voltage current to distant points with small line losses. The current is carried from the station over the transmission or "high line" to a substation or distributing center. At the substation, the voltage is stepped down. There may be a single substation, if the city is small, or several to service different districts of a larger city. From the distribution center the current is carried to individual sections by distribution lines.

National Electric Code

All electric wiring installations should conform to the National Electric Code. This code consists of regulations and standards, set up by the Electrical Committee of the National Fire Protection Associ-

[1] *Edison Electric Institute Bulletin.*

ation, which have been approved by the American Standards Association and adopted by the National Board of Fire Underwriters. Most cities and towns require that all electric wiring conform to the National Electric Code, but in rural sections unless there are state requirements the regulations regarding wiring installations are left to the company furnishing the power. The scope of the code includes regulations regarding the conductors that connect the installation to the supply of electricity and regarding the wiring and equipment installed within public and private buildings and on the premises. The code is revised biennially. .

Customers' circuits

From the distribution lines service circuits lead to the individual houses or buildings. These circuits usually are of the single-phase two- or three-wire type, and may be installed either overhead or underground. If only lighting and small appliances are used, the two-wire 115-volt circuit is most common. If an electric range, water heater, or motor larger than ⅓ horsepower is used, a three-wire 115–230 volt circuit is required. In the installation of a new wiring system, this volt circuit is recommended. In multiple dwellings and large buildings, where there is a heavy load demand, a three-phase four-wire system is becoming popular.

According to National Code regulations, the overhead service conductors must have an insulated covering that will normally withstand exposure to atmosphere and other conditions of use. The conductors must be attached to the side of the building by means of insulators 10 feet or more above the ground and be carried down the wall to the point at which they pass into the interior, either through conduit pipe or in the form of an entrance cable. Conduit pipe is used largely where there is danger of injury to the service conductors. It is required by some power companies, as it decreases the possibility of the consumer tapping the line ahead of the meter. Entrance cable, however, is used more extensively, as it gives good service and is less expensive to install. If underground services are used, they must be installed in a duct, conduit, or in the form of a cable approved for the purpose. Underground service is not common because its installation cost is higher than overhead and it is more difficult to repair.

The service conductors pass through the walls of the building in an insulated tube, usually at a point as near as possible to the service equipment.

MASTER CONTROL OF BUILDING WIRING SYSTEM

The code requires that each set of service entrance conductors shall be provided with an easily accessible means of disconnecting all conductors from the source of supply. This control is required so that in an emergency the entire wiring system may be disconnected from the distribution system. The disconnecting means may be either a set of switches or circuit breakers or a single disconnecting device. If there are more than six separate subdivisions of the service, a single control of the current is required. If the controlling device is a switch, its rating must not be less than that of the fuse holder in series with it. In general, three sizes of service entrance equipment are used: two-wire 30-ampere and three-wire 60- or 100-ampere.

OVERCURRENT PROTECTIVE DEVICES

Electric circuits must be protected from overloading by fuses or circuit breakers.

Fuses are of two types, plug and cartridge. Plug or cartridge fuses are used in 110- to 125-volt circuits and are rated 0–30 amperes.

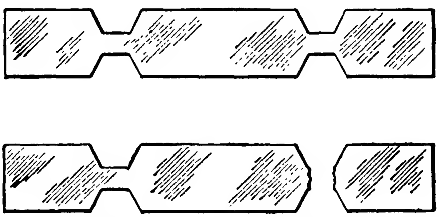


FIG. 28. A fuse "blows" when the link melts.

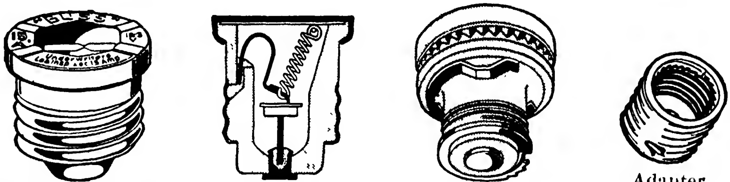
Higher-voltage circuits require cartridge fuses which are rated 0–600 amperes. Each type contains a link strip of metal alloy which has a definite current-carrying capacity. When an excess of current passes through the alloy strip, sufficient heat is developed to melt it. (Fig. 28.)

In the plug fuse the alloy strip is enclosed in a porcelain, glass, or plastic cup that screws into a socket. The contact tip of the screw base is of copper or aluminum and is usually marked with the ampere-carrying capacity. A mica or glass window over the metal strip makes it possible to see when the fuse has been blown. (Fig. 29.)

A new development in the plug fuse is one which contains several, usually six, fuse strips. The fuse is designed with a rotating contactor on the cap so that, when one fuse strip melts, the contactor can

be turned manually to introduce another fuse strip into the circuit. One type of the multistrip plug has on the contactor a neon bulb that shines when the fuse melts. This type is known as the "Signalite."

The ordinary plug fuse has very little time lag and therefore will usually blow with only a momentary overload, such as the starting current of a household motor. To overcome this, manufacturers have developed a fuse with a time lag that eliminates unnecessary interruptions of service due to momentary overloads. This fuse, known as a Fusetron, has a thermal cutout in addition to the fuse link. (Fig. 29.) On a short circuit, the fuse link blows just as in an ordinary fuse; but



Bussman Mfg. Co.

FIG. 29. Different types of plug fuses.

with an overload the excessive current causes the cutout to heat and, if continued, softens the solder in it and permits a spring to pull the fuse link from its normal position in contact with the thermal cutout.

Up to 1935 all plug fuses were made for bases of the same size, permitting persons ignorant of the importance of proper fuse protection to use too large a fuse. Inspectors also found many people wiping out all protection by bridging across under the fuse with a penny or other material of good conductivity. To guard against this practice, a fuse known as the Fustat was developed. (Fig. 29.) The base of this fuse is designed to prevent the use of too large a size and to prevent the use of pennies or other bridging material. It is made to fit into the standard-base fuse holder by means of an adapter that locks in place. (Fig. 29.) The Fustat can then be removed and replaced like the ordinary fuse. The Fustat is made with the thermal cutout so that unnecessary blowouts from starting currents of motors are eliminated.

The cartridge fuse may be purchased in several types: ordinary one-time fuses, which have comparatively little time lag and require the replacement of the entire fuse when blown; ordinary renewable fuses, which need only to have the fuse ribbon replaced; superlag renewable fuses, which have a greater time lag than the ordinary re-

newable fuse; Fusetrons which have a long time lag but require the replacement of the entire fuse when blown. (Fig. 30.)

Fuses are tested by the National Board of Fire Underwriters and must meet certain standards for safety in order to carry the inspected label of the Underwriters' Laboratories. This label is the consumer's guarantee for safe construction and operation.

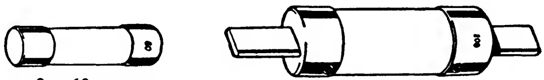


FIG. 30. Two types of cartridge fuses.

A circuit breaker is a device usually constructed with a bimetal strip which opens the circuit automatically when the current in the circuit becomes excessive. The circuit breaker is reset manually when the cause of the tripping has been removed.

METER

In the use of the electric current the homemaker is chiefly concerned with the quantity of work electricity will do for her and the rate at which it will accomplish the work. The rate at which work is done is known as power, and the unit of electrical power is the *watt*. The watt is equal to a volt times an ampere. The watt is such a small unit that the *kilowatt*, 1000 watts, is used commercially in measuring power. The homemaker is not so much interested in power alone as in the length of time through which the power is used. Multiplying power expressed in kilowatts by length of time in hours give *kilowatt-hours*. The kilowatthour is, accordingly, the unit in which electrical energy is sold by the power company to the consumer. The electric meter records on a register the number of kilowatthours of electricity consumed.

In the kilowatthour meter two types of registers are used. One register consists of a series of dials which are interconnected by a system of cog wheels. Each dial is numbered in the reverse direction from the dial preceding or following it. (Fig. 31.) In making a reading, the digit on each dial immediately preceding the pointer is read. Some authorities suggest reading the dials from right to left and setting down the numbers backwards. This method eliminates any question with regard to the position of a pointer. The correct reading of the meter in Fig. 31 is 1385 kilowatthours.

With the development of the national rural electrification program, efforts were made to cut operating costs of the power companies.

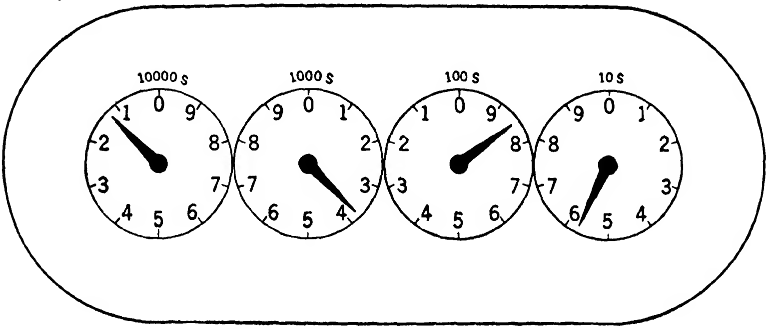
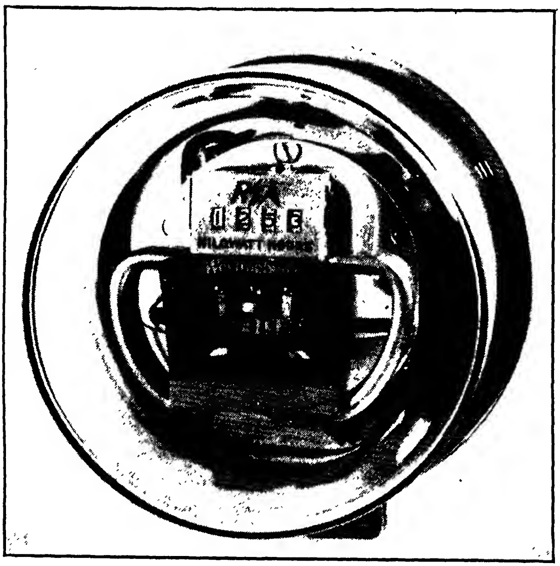


FIG. 31. Dials of an electric meter.

This led to the use of the cyclometer register, which was originally used on early meters. This register is the same as that used on auto-



Westinghouse

FIG. 32. Kilowatthour meter with cyclometer register.

mobile speedometers and can be read easily by the consumer. (Fig. 32.) Meter readings in many rural sections are taken by the consumer and mailed to the power company.

In early installations the meter was installed inside the building. Now outside installations are common practice. Outside installation makes the meter always accessible for monthly readings.

Distribution panel and branch circuits

From the meter or master switch the wires run to a panel containing the fuses or circuit breakers which protect the several branch house circuits. House circuits may be of several types: lighting circuits, appliance circuits, combination circuits, and power circuits. The lighting circuits supply current to lighting outlets only; the appliance circuits supply current to convenience outlets. Both lighting and convenience outlets are on the combination circuits. The outlets for the range and for the water heater are on separate circuits, known as power circuits. All outlets are wired in parallel.

A special type of house wiring known as the radial system is discussed in the chapter on home lighting (p. 362).

Size of wire

The size of wire used in the circuits is dependent on the quantity of current the wire is required to carry. For convenience the sizes of wire are designated by gauge number. The wire gauge most commonly used in the United States is the B. & S. gauge of the Brown and Sharpe Manufacturing Company. Gauges are marked 0000, 000, 0, 1, 2, 3, etc. As the numbers increase in numerical value, the size of the wire decreases. The gauges most frequently used in the home are 14, 12, and 10 for lighting and appliance circuits and 6 for the range circuits. Larger appliances, such as the water heater, ironing machine, and glow heater, should use 12 wire. Gauges 16 and 18 are used in flexible cords for portable lamps, and 14 for small heating appliances. Systems of house wiring and regulations with regard to the different circuits are discussed in the chapter on home lighting.

Cost

Electricity at the central station is a relatively cheap commodity, in many plants the cost being less than 1 cent per kilowatthour. But the initial cost of the chemical or mechanical energy that is converted into electrical energy is only a small fraction of the cost of the electricity delivered in the home. Rates per kilowatthour vary in different sections of country and with different power companies. The cost of using electricity depends upon the rate per kilowatthour and upon the length of time the appliance is used. In general, heating appliances

such as ranges, water heaters, ironing machines, and roasters use more energy than do motor-driven appliances like the washing machine and vacuum cleaner. The electric refrigerator, although a motor-driven appliance, uses considerable energy because of its continuous use.

Name plate

Electrical appliances are constructed to operate under certain standard conditions specified on the name plate. These specifications include kind of current (alternating or direct), frequency of current, volts, and either watts or amperes.

In the selection of lighting equipment and heating appliances, the kind of current is not of importance unless the appliance is equipped with an automatic control. Lighting and heating effects are produced by the resistance of the conductor to the passage of the current, and it is immaterial whether the current is always flowing in the same direction or alternately changing its direction. Automatic temperature controls, however, are designed for a definite kind of current, as are electric motors, with the exception of the universal motor, which will operate on either direct- or alternating-current circuits.

An appliance must be designed for the voltage on which it is to be used. Voltage forces a current through an appliance against resistance. The resistance depends upon the material of the conductor, the length of the conductor, and its cross-sectional area. The resistance varies directly with the length and inversely with the cross-sectional area. Electrical resistance is measured in *ohms.* In 1827, a German scientist, Dr. G. S. Ohm, discovered that the current, the voltage, and the resistance bear a definite relationship to one another. This is expressed in Ohm's law: I, the intensity of the current, is proportional to E, the difference in potential. When I is measured in amperes, E in volts, and R in ohms, the law may be expressed as

$$I = \frac{E}{R}$$

This relationship finds many practical applications in the construction of electrical household equipment. If a definite number of amperes of current at 115 volts pressure is required to produce the heating effect necessary for toasting a slice of bread in a given time, the manufacturer determines the ohms of resistance that must be used in the heating coil to give this number of amperes.

After the toaster has been constructed the resistance becomes a fairly constant quantity, and the current is directly proportional to

the voltage of the circuit. If the toaster is always used on a circuit of 115 volts, the necessary heat is produced in the given length of time. When used on a circuit of less than 115 volts, not enough heat is developed to toast the bread in the required time, and, if the pressure is more than 115 volts, sufficient heat may be produced in the given time to burn the bread.

If the difference in rated voltage is large, the effect is even more marked. When a lighting or heating appliance designed to use 115 volts is operated on a 32-volt home system, not enough heat is generated to be of use, whereas the heat developed when a 32-volt appliance is used on a 115-volt circuit will burn out the appliance. An application of Ohm's law will make this clear.

For example, if a toaster is designed to be operated on a 115-volt current and is rated at 575 watts, the resistance of the heating coil is 23 ohms. If the toaster is used on a 32-volt circuit,

$$I = \frac{32}{23} = 1.3$$

$$W = (1.3)(32) = 41.6$$

If the power used is only 41.6 watts instead of 575, the heat produced will be negligible. A toaster designed for 32-volt current and rated at 575 watts has a heating coil with approximately 1.8 ohms of resistance. If the toaster is connected to a 115-volt circuit,

$$I = \frac{115}{1.8} = 63.9$$

$$W = (63.9)(115) = 7348$$

In this case the power used is 7348 watts or more than 10 times the wattage rating of the appliance. If the circuit to which such an appliance is connected were not protected by a fuse or circuit breaker, the element in the appliance would be destroyed.

The watts or horsepower specified on the name plate tell the rate at which the appliance uses electric energy. Lamps and heating devices are rated in watts; motors are rated in watts or in horsepower. Lamps commonly used in the home are 25, 40, 50, 60, 75, 100, 200, and 300 watts. Ironing machines may be rated as high as 1500 watts and water heaters 3000 watts. Electric ranges are rated from 7400 watts to 18,500 watts. Household motors are $\frac{1}{32}$, $\frac{1}{16}$, $\frac{1}{10}$, $\frac{1}{6}$, and $\frac{1}{4}$ horsepower, depending upon the type of appliance. One-fourth

horsepower on the name plate of a motor means that the motor has been constructed to perform work at that rate without overheating. In performing work a motor does not function at 100 per cent efficiency; therefore, in computing cost of operation a specific efficiency must be considered. With fractional-horsepower motors used in home appliances this value is approximately 50 per cent. For example:

$$1 \text{ horsepower} = 746 \text{ watts}$$

$$\tfrac{1}{4} \text{ horsepower} = 186.5 \text{ watts}$$

If the motor is 50 per cent efficient, the actual power used would be twice 186.5 watts or 373 watts.

Home plants

Electricity from central stations is not yet available in all rural sections of the country. In certain rural territories, because of the low population density, high line current is not practical. For these districts electricity is made available by the individual home plant. Home generating plants are classified as three types according to the form of energy used to run the generator: gas-engine, wind-power, and water-power plants. The largest percentage is of the gas-engine type, for it is adaptable for use in all sections of the country. Gas-engine plants are of two kinds, battery and non-battery.

The battery plant consists of a direct-current generator, a gasoline engine, switch, instrument panel, and storage batteries. The batteries may be hand controlled or semiautomatic.

In the hand-controlled plant the gasoline engine drives the generator to maintain the voltage at the terminals of the batteries. The distribution system operates from the batteries. When the voltage of the batteries drops to a certain point, a switch known as the "low-voltage release" disconnects the batteries from the line. Before the plant can again be put into operation, this switch must be closed by hand and the engine started to recharge them. The frequency of recharging depends upon the size of the batteries and the number of lights and appliances used in the system.

The more recently designed systems are semiautomatic. These plants operate from the storage batteries until a definite quantity of current is used; then the generator automatically starts running and the current is taken directly from the generator.

The non-battery type replaces the large storage batteries with a small battery that is used only for starting the motor. These plants

are completely automatic in that the turning on or off of a light or of an appliance starts and stops the generator. The only energy that is stored is in the small battery which is used for starting purposes.

Capacity of battery plants

Battery plants may be purchased in 32-volt 16-cell plants or in 110-volt 56-cell plants. The capacity rating of the battery plants varies from 600 to 15,000 watts. Non-battery plants are designed with both 32- and 110-volt generators.

Cost

The initial cost of the different types of home plants varies according to the size of the generator and the number of cells in the battery. Extensive surveys of gas-engine plants show the average life of this type of plant to be approximately 10 years. The average life of the storage battery is 6.3 years.

Use of equipment with house plants

The equipment that may be used on a home plant depends upon the type and wattage. Lighting equipment is purchasable for both 32- and 110-volt systems. Small heating appliances such as electric irons, toasters, waffle irons, percolators, heating pads, glow heaters, hot plates, and incubators, whose wattage runs below 650 watts, can be used successfully on the average plant. Care must be taken, however, not to overload the plant by operating several appliances or one appliance and several lights at the same time. Plants of 110 voltage, of either the battery or non-battery type, usually have a greater wattage capacity, so that it is possible to operate more equipment at one time. Standard equipment is designed for a 115-volt system. Appliances for use on the 32-volt system must be of special construction and are often somewhat more expensive than the standard pieces.

Ironing machines and 1000-watt irons may be used successfully on plants of 1500- to 15,000-watt capacity, and small electric motors can usually be operated on the home plant. Although 1 horsepower is equivalent to 746 watts, it has been found, as noted, that fractional-horsepower motors used in the house are only about 50 per cent efficient and, therefore, take at least twice as much power as their rating would indicate. A drop of more than 5 per cent in line voltage affects the efficient operation of a motor. On a 32-volt system the motor must be used within close range of the generating plant.

Motors used in connection with automatic equipment such as water systems and mechanical refrigerators often introduce a problem. Shallow-well systems which do not use a motor larger than ¼ horsepower can usually be operated with safety from any system; but deep-well systems, which require a larger motor, should not be used on small-wattage battery plants, for they are likely to operate when the battery is already carrying a heavy load.

Logan, in his discussion of farm lighting systems, states, "Operating an electric household refrigerator from an individual farm electric plant has been a questionable procedure. During the summer months the refrigerator motor starts frequently and runs a considerable portion of the time, consuming from 50 to 75 kilowatthours per month. If this energy is taken directly from the battery it is quickly discharged and the frequent charging and discharging materially shorten the life of the battery. On the other hand, if the refrigerator motor starts the plant and takes its energy directly from the generator, other difficulties arise. To some the noise of the plant is objectionable, especially at night, and unless the charging rate of the battery is carefully regulated the batteries will be continually overcharged." [1] Although the efficiency of refrigerators has been decidedly increased, their use on the small home plant is still questionable.

Electric motors

An electric motor is a device for changing electrical energy into mechanical energy. Its operation is brought about by the force action between two magnetic fields, just as the magnetized compass needle moves when brought into a magnetic field stronger than the earth's field. The magnetic fields in the motor are made by electromagnets.

The motor has three principal parts: the field coils, the armature coils, and the brushes. When the two sets of coils are electrically energized, the reaction between the two fields produced by the current causes the rotation of the armature coils, which are supported on a central spindle. The turning action is transmitted to the mechanical device attached to the motor and work is performed.

Depending on the type of motor, the armature may or may not be connected to a source of electricity. The field coils are always so connected. If the motor is a universal type, which can be used on either direct or alternating current, the two sets of coils are connected in series. This necessitates a sliding connection between the

[1] C. A. Logan, *Farm Lighting System*, p. 28.

armature coils and the field circuit. Such a contact is obtained by means of brushes and copper commutator bars. The bars, insulated from each other, form a cylinder on the armature spindle and are connected individually to the coils of the armature. The insulated segments deliver the current received from the brushes to the armature. When the motor is operated on alternating current the flow of current through the field windings and through the armature wires reverses at the same rate, and the resultant force produces a torque action turning the armature in a single direction.

After the armature starts rotating it is revolving in a magnetic field and thus generating in its coils a new electromotive force, which is opposite to that impressed by the electric source. The faster the armature turns, the greater the counter electromotive force produced and the lower the resulting voltage operating the motor. The lower voltage reduces, in turn, the actual current through the coils and acts as a brake on the motor. On the other hand, if the motor is heavily loaded, the rotation speed is decreased, the counter electromotive force is reduced, more of the line voltage is effective, and a greater current flows. If the load is excessive, the greatly increased current makes the motor hot and may even "burn it out." Care should be taken to connect the motor to its rated voltage, to keep it properly oiled to reduce any friction to the minimum, and to use the motor under no load greater than the maximum allowed.

Some appliances have a protective device which breaks the circuit when the current through the motor endangers the windings. Such a device is very desirable in refrigerators and home freezers because conditions causing an overload cannot always be controlled manually.

In addition to the universal type, a common alternating-current motor used in home appliances is the induction motor. When this motor is started, the armature is generally connected to the circuit, but as it gains speed the initial contact is automatically broken and the armature operates as a result of the induced current in its coils.

Constant-speed motors used in the house have a means—usually in the form of a small condenser—of boosting the current when the motor's speed slows and of opposing the increased current when the load is reduced. This type of motor is usually found on such appliances as the small mixer where constant mixing at various settings is especially desirable.

Small household motors are approximately 50 per cent efficient and require twice the current indicated by the horsepower rating.

Construction features affect the life of the motor. Sometimes these features may be observed in selecting the motor-driven appliance, but frequently they can be learned only from descriptive material or from asking questions.

In high-grade construction a baked-on coating of plastic or good-quality varnish is used to protect the wires against heat, moisture, and mechanical injury. This coating also serves to hold the armature coils in position. Commutator bars are of copper and are insulated from one another with mica segments which should be "undercut" so that the copper extends well beyond them. A large number of commutator bars gives a more uniform torque and decreases the drop in potential between the bars, which tends to reduce sparking. Motors should not spark excessively. Sparking may also be caused by worn carbon brushes, by an irregular surface on the commutator, or by both. Once started, sparking generates excessive heat which roughens the bars. The rough surface, in turn, tends to wear away the ends of the carbon brushes, and a vicious circle is produced. Well-fitting brushes will save servicing costs. Worn brushes may be readily replaced, however, and are inexpensive. If necessary, the commutator bars may be resurfaced.

As has been mentioned previously, overloading the motor may cause increased heating within the motor and injure it. If the motor is not properly lubricated, unnecessary friction adds to its working load. Care should be taken to follow the instructions of the manufacturer in oiling the motor. Lifetime lubrication incorporated in some motors should eliminate this problem, but the motor should have proper care in other respects. Motors stored in cold places should be allowed to reach normal temperatures before use. A clean, dry storage place is requisite for all motor-driven appliances.

The name plate on a motor should contain the following information: the line voltage at which it should be operated; the type of motor, alternating or direct current or universal; the frequency of the alternating current; the horsepower for which it is designed if it is to be subjected to varying loads, or, if operating under constant load, the maximum power it should draw from the line; the serial number and manufacturer's name for identification of parts when repairs are needed.

Summary

The electric current is used in the home as a source of heat, light, and power. The current is obtained from a home plant or is brought to the home

from the central station over a system of transmission and distribution lines. An understanding of the generation, transmission, and use of electricity involves a practical knowledge of the following terms: generator, transformer, conductor, insulator, circuit—open, closed, short, and grounded—wire gauge, volt, ampere, ohm, watt, fuse, circuit breaker, kilowatthour meter, name plate, Ohm's law, and motor.

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4

Small Electrical Appliances

IT IS NOT POSSIBLE to discuss at length each of the small appliances that may find a use in the home. But an attempt will be made to indicate in a general way what the housewife should know before purchasing one of these appliances and the points in construction, ease of operation, and ease of cleaning that influence the efficiency of any piece. Materials used in household appliances have been considered in Chapter 1. In this chapter mention will be made of the common materials used for the appliance under consideration, but no details of the manufacture will be given.

Small electrical appliances include roasters, table units, grills, percolators and other coffee makers, toasters, waffle bakers, egg cookers, mixers, churns, and pasteurizers. They will be considered in the order named.

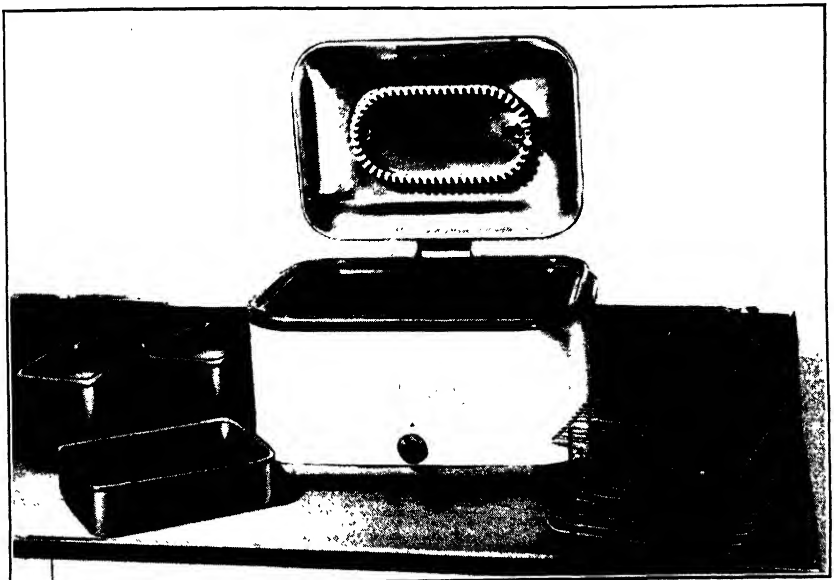
ELECTRIC ROASTER

The electric roaster has almost the versatility of a kitchen range, with the advantage of connection to a convenience outlet. It may be used for roasting, baking, stewing, steaming, and boiling, and with the grill attachment for broiling, toasting, and frying. (Fig. 33.)

The roaster, oval or rectangular in shape, is of welded steel, frequently bonderized to prevent rusting, finished on the outside in black, cream, or white baked enamel, with chromium trim and plastic handles. A large inset pan of porcelain enamel on steel is left in the roaster during all cooking operations; smaller dishes of aluminum, enameledware, heat-resistant china, or glass hold the foods to be cooked. The dishes of glass and china may also be used for table service and for refrigerator storage. They are of varying sizes, adapted to different amounts of food.

The lid of the roaster is of aluminum, stainless steel, or a stainless alloy. Some lids have a heatproof glass panel beneath the handle so that the operator can note the progress of the cooking. The cover is usually entirely separate from the body of the appliance, but on some roasters there is a hinge that permits the lid to be tilted upright

or removed, according to preference. One model has a hinged cover that is controlled by a dial on the front panel; the control causes the cover to lift automatically, so that there is no danger of burns from steam. Others have a wire or plastic device attached to the body of the roaster. This holder supports the lid on end or side in such a way as to prevent dripping. The grill or broiler unit may be clamped inside the cover or may be supported by the baking rack.

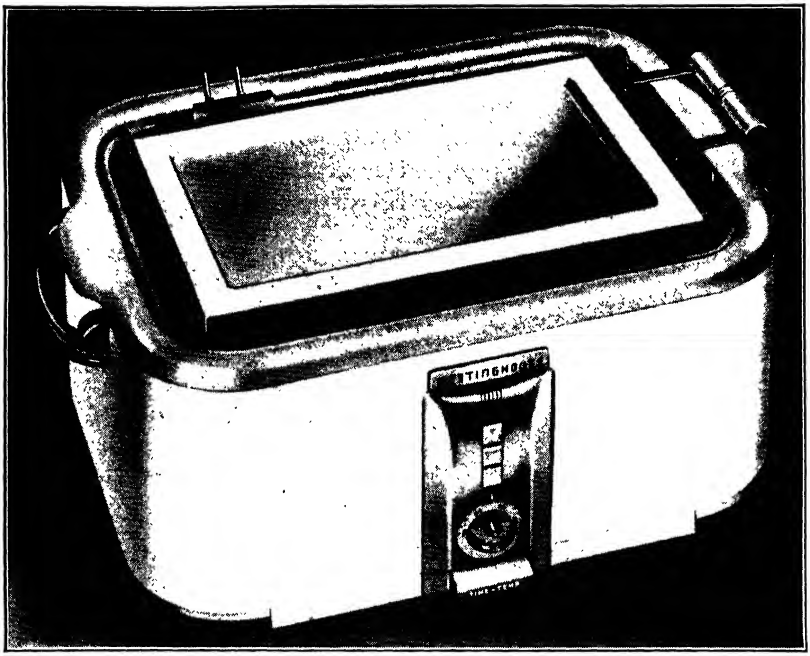


Proctor Electric Co.

FIG. 33. Electric roaster. In this model the grill unit is attached inside the cover.

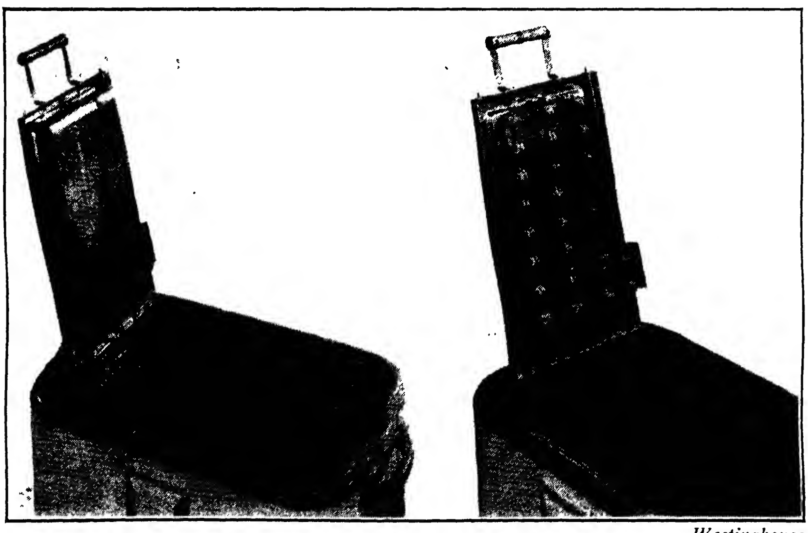
It is often covered by a grid plate on which food may be fried. (Fig. 34.) The operation is hastened by a metal reflector fastened below the heating element; the reflector is removed during broiling. (Fig. 35.)

The body of the roaster is insulated with rock or glass wool or spun glass, 1 to 2 inches thick. The lid may be insulated or not, depending on the manufacturer. A vent is often provided for the escape of steam. The heat is thermostatically controlled with temperature variations corresponding to those of the range oven. The roaster unit usually has a rating of 1320 watts; the grill unit varies from 1320 to 1620 watts, depending upon the model. Several models have a built-in clock control to turn the electricity on and off at any desired time. Because broiler and roaster units together have a rating of approxi-



Westinghouse

Fig. 34. Grill unit with grid plate in place.



Westinghouse

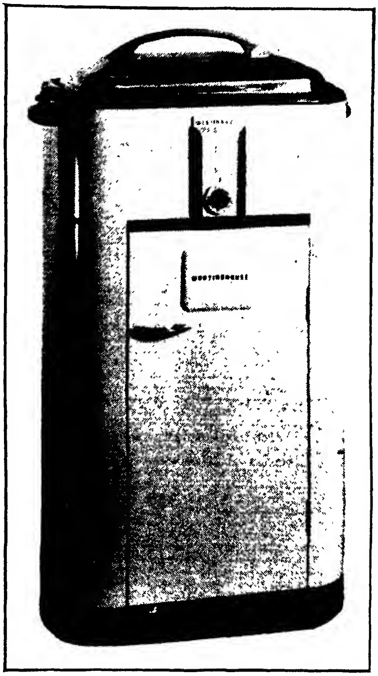
Fig. 35. Broiler unit with and without metal reflector.

mately 2600 watts, they cannot be used simultaneously on the same circuit without overloading it.

Sturdy racks of stainless or plated steel, into which the dishes fit, minimize the handling. Flat racks are provided for cake and pie pans and cookie sheets, which may or may not be supplied as standard equipment. The roaster may be used for single cooking operations, for an entire meal, and, at the lowest setting of the thermostat, for keeping food warm. It should be preheated for baking, but roasting and whole-meal cookery may be started cold.

A drip-back rim prevents grease from running to the outside. Rounded corners and unions in the lining and dishes simplify cleaning. The body of the roaster or the grill unit should not be immersed in water.

Stands, especially designed for holding the roaster, are available. They are of steel, finished in synthetic enamel, and may be obtained in either cabinet or table styles, supplied with casters for ease in moving. Additional shelves provide storage space for the roaster dishes and broiler attachment. (Fig. 36.)



Westinghouse

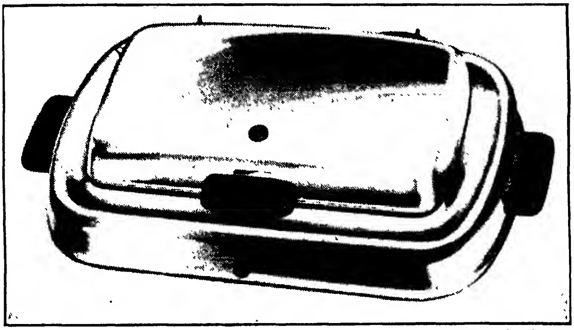
FIG. 36. Roaster cabinet especially designed for holding roaster. Two shelves for storage are concealed behind door panel.

Small roasters are usually sold as electric casseroles. They are oval or round and have a porcelain enameled or heatproof china cooking well but no inset pans. Some of these roasters are large enough to hold a 10-pound ham or a small fowl.

TABLE STOVES AND GRILLS

The more flexible roaster has largely replaced the uninsulated table stove once used extensively to poach eggs and make toast for breakfast and cook one- and two-dish luncheons and suppers. At best it served only a very limited number, but it could be used at the

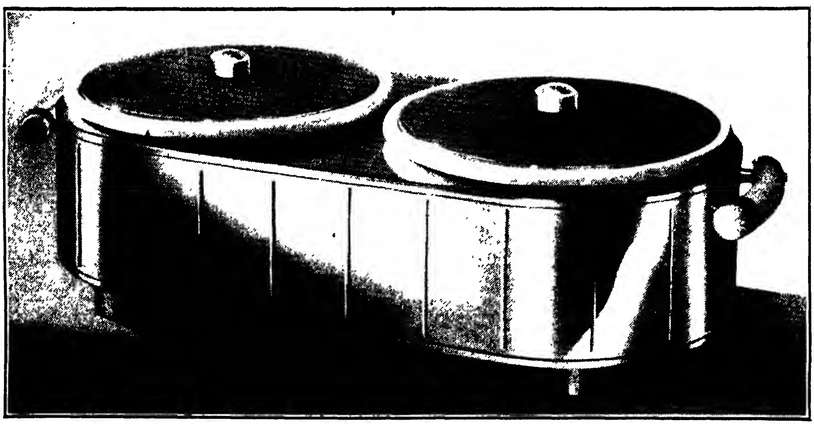
table and it added a friendly informality to the meal. The grill meets a similar need now. It will toast bread and sandwiches, fry bacon and eggs, broil steaks and chops, and bake pancakes, to mention only



Westinghouse

FIG. 37. Electric grill. The signal light, visible from any angle, indicates when selected temperature is reached. Heat shield is in the base. Waffle grids are also available.

a few of its uses. The cover also is heated and, turned back, furnishes additional surface. Some models have reversible or interchangeable grids for making waffles. A small drip pan may be attached beneath the spout to catch any grease. (Fig. 37.)



Universal

FIG. 38. Buffet server.

The grids are of cast aluminum, the exterior finish of chromium, and the handles of plastic or wood. The temperature may be automatically controlled, and a pilot light may indicate the correct heat.

With the introduction of the vacuum-type coffee maker, a small electric unit became a part of the dining-table equipment. It or a similar unit, designed for table use, will keep food warm for late rivals, or a buffet server may be used for this purpose. The one illustrated in Fig. 38 has two china-lined compartments, one divided into three sections so that a number of foods may be kept warm at one time. If the current is disconnected and the surrounding container filled with ice cubes, summer foods may be chilled.

Coffee makers

Coffee may be made by several different methods, but the electric appliances used for the purpose are the percolator and the vacuum-type coffee maker.

Better grades of percolators are made in one piece without seams. They are usually of copper, plated on the outside with nickel or chromium or sometimes with silver, on the inside with tin. (Fig. 39.) Some are of Pyrex or vitrified china. They are marketed in two general styles, the pot and the urn, each in a variety of sizes designated in cups. The standard cup used in measuring has a capacity of 6 ounces, which is equal to three-quarters of the regular measuring cup.

Universal

Fig. 39. A percolator that can be regulated to produce strong- or mild-flavored coffee.

The percolator may be heated by an insulated unit beneath the pot or by a Calrod unit, which is an immersion type, projecting into the bowl and heating the contents by direct contact. A percolator is usually rated at about 400 watts, but some units are as high as 625 watts.

The perforated coffee basket is fastened to a stem that rests on the floor of the percolator bowl or on the top of the immersion unit when that is used. The basket should fit tightly so that it will not tip; otherwise passage of water through the grounds is retarded. The lower end of the stem has a valve. Water is forced or pumped up through the stem, sprays over the coffee in the basket, filters down through it,

extracting the essence from the coffee, and drops back into the bowl. Some baskets have a spreader plate with very tiny openings through which the water must drip before reaching the coffee.

Cold, freshly drawn water should be used. A very small quantity of water is admitted at one time to the valve chamber. There it is heated and is forced up the valve stem, and another small amount of water takes its place. In this way only enough water is heated at a time to spray over the ground coffee at the correct rate to extract the desired flavor from the grounds. Such a small quantity of water rising through the stem at one time becomes cooled below the boiling point before it strikes the coffee. This is considered desirable for the extraction of the best flavor. Gradually, however, as percolation continues, the pot becomes hotter, and the water reaching the coffee is also hotter.

Manufacturers' directions should be followed, but, in general, a percolation period of 5 to 6 minutes is necessary to produce a moderately strong coffee. A measure of 1½ tablespoons of medium-grind coffee to each cup of water is recommended. For a stronger coffee, use more coffee; for a weaker coffee, less. Increasing the time of percolation will also give a stronger coffee, but too long a period tends to cause a bitter flavor. The real flavor is extracted in a short time. Coffee should be served immediately; if this is not possible, it must be tightly covered to keep the aroma from escaping.

The temperature is usually regulated by plugging in or pulling out the plug, but some percolators have a thermostatic control that holds the temperature comparatively constant or a time control that automatically stops the action when percolation is complete. All percolators should have a protective device, either a fuse or an automatic cutout, to shut off the current if the water boils away. Extra percolator fuses should be kept on hand so that a burned-out fuse may be replaced without the necessity of sending the percolator to the power company or to a repair shop. The automatic cutout may be reset without the bother of replacing a fuse.

The percolator should be well balanced with a sufficiently broad base to eliminate any tendency toward tipping. Handles and base must be insulated to prevent damage to the table or difficulty in serving. The spout or faucet should not drip, and an attached lid is usually considered a convenience. The terminals to which the plug is connected should be protected with a surrounding shield of metal.

To make good coffee, not only must the coffee be fresh, but the percolator must be spotlessly clean. The valve, stem, and spout

should be cleaned with a stiff brush. The electric unit must not be put into water, but the percolator bowl may be washed out with warm soapy water and then rinsed with clear hot water. There is an oil in coffee that tends to deposit on the inside parts. This deposit may be prevented by percolating hot soapy water in the pot about once a week and allowing the dry pot to stand open to the air. Avoid percolators with unnecessary seams and crevices where dirt may collect. A smooth, durable finish is easily kept clean. Parts for replacement should be readily available.

Most drip coffee is not made electrically, but some drip pots are provided with a stand containing a heating unit upon which the pot may be placed to keep it hot. The unit is so regulated that the coffee cannot boil.

Coffee is frequently made in a vacuum-type pot formed of two containers, the upper constructed with a siphon tube that extends nearly to the bottom of the lower bowl. A rubber gasket makes an airtight seal between the bowls. The bowls are of heatproof glass, of aluminum, or of steel plated with chromium. (Fig. 40.) The cup capacity may be marked on the side of the lower bowl. Plastics are commonly used for handles, covers, and trim. The coffee maker is supplied with a stand containing a heating unit, or the electric unit may be built into the base of the lower bowl.

Coffee is measured into the upper bowl and is prevented from falling into the lower bowl by a ceramic plate, with or without a porous cloth covering, or by a glass rod. The water is in the lower bowl. When the water has been heated sufficiently, the pressure of the air and steam on the surface of the liquid forces it through the siphon tube into the upper bowl. The water should have a temperature between 185° and 205° F. when it comes in contact with the coffee. Water not hot enough fails to extract the full flavor; water too hot dissolves the undesirable oils and tannin that cause a bitter taste. The water should remain on the coffee from 1 to 3 minutes. Some directions suggest stirring the grounds and water for more thorough mixing. To prevent breakage, a small amount of water must remain in the lower bowl of glass, but all the water may be forced out of the metal bowl.

When the pot is removed from the heating element the steam condenses, leaving a partial vacuum in the lower container, and the difference in pressure causes the water to drip back through the coffee into the lower bowl. In some coffee makers the electricity is automatically shut off when the coffee has brewed sufficiently, so that

uniformity of flavor is assured each time. The control on pot or separate unit is then reset to keep the coffee hot, or it resets itself automatically.

When it is time to serve, the top bowl is lifted off and the coffee is poured from the lower container. At least one company facilitates the removal of the upper bowl by providing a special device that

(*a*) *Silex Co.* (*b*) *Sunbeam*

FIG. 40. (*a*) Vacuum-type coffee maker of glass, with separate heating element. (*b*) Vacuum-type coffee maker of metal, with built-in heating element.

releases the bowl instantly at a slight pressure of the thumb. A decanter cover is also supplied. It snaps into the lower bowl and permits easy pouring through its spout, without lifting of a cover. When a cloth pad is used, it must be carefully washed after each use and boiled about once a week in clear water. Never use soapy water.

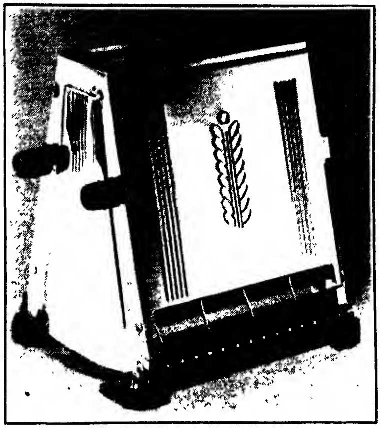
As a result of a series of experiments on making coffee in percolators, dripolators, and vacuum coffee makers, Potter and Fuller noted that, although the proportion of coffee and water and the time and temperature of percolation all had an effect on the products from the different makers, the ability to handle coffee grounds seemed to be the factor that most affected the quality of the beverage. They found that the cloth filter prevented fine particles of coffee from appearing

as a sediment in the cup. The presence of sediment was detrimental to color, appearance, and flavor. They recommended "drip-grind" coffee for most satisfactory results in all types of coffee makers.

Toasters

Most toasters are made to toast two slices of bread at a time. Bread that is properly toasted will have a uniform golden-brown color on both sides, will be tender, and will break readily without being brittle.

The toaster is made of pressed steel plated with chromium. Handles and feet are commonly of plastic, occasionally of wood. All handles should be well insulated to prevent burning the fingers in turning the toast, and the bottom should be insulated to prevent damage to the table. On many toasters the cord is permanently attached.



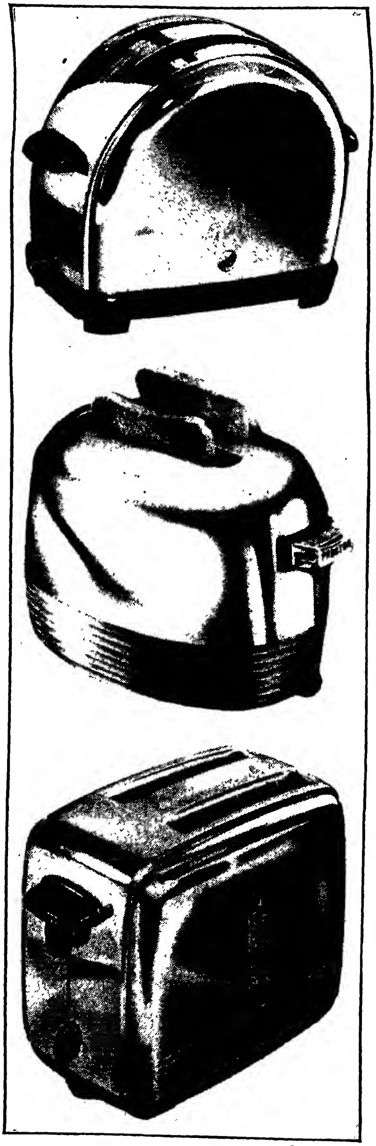
Westinghouse

Fig. 41. Turnover toaster.

The toaster may be automatic, semiautomatic, or operated by hand; it may toast first one side of the slice of bread and then the other, or both sides at once. The size and type selected will depend upon the quantity and quality of toast desired and the amount of money available for the purchase.

Toasters are of two types. One has reversible or turnover sides, hinged at the bottom, and has the heating element in the center. (Fig. 41.) The slices are placed in approximately vertical racks on either side of the element, and when one side of the bread is toasted the slices are reversed by hand, by flipping, or by turning one rack at which the other rack turns automatically. This type may give somewhat dry toast, since the side of the slice away from the element is drying out while the other side is toasting, the dryness depending upon the speed with which the toasting is accomplished. Oven- or well-type toasters toast the bread on both sides at the same time by units placed on either side of the rack. Slices of bread toasted by this method are moist in the center. (Fig. 42.)

In all the toasters, wire guards keep the bread from coming into contact with the unit. These guards prevent the radiant heat from



Sunbeam
Universal
Proctor

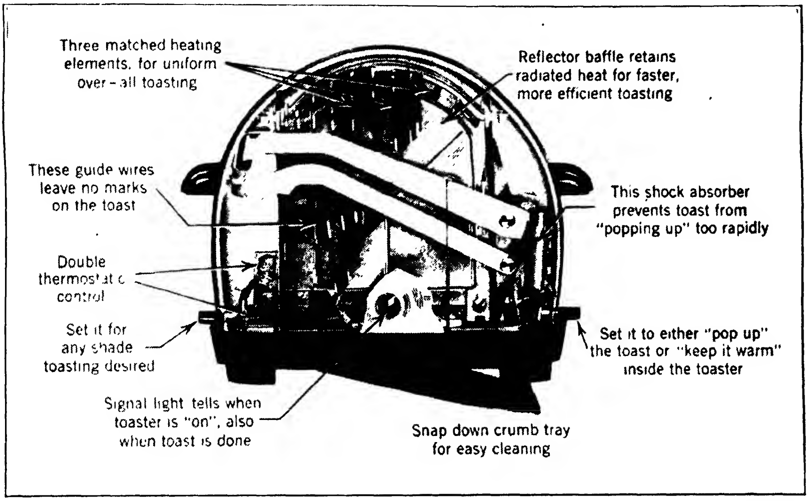
FIG. 42. Well-type toasters.

reaching all the slice directly and so cause light streaks on the bread, which detract from the appearance of the toast. One manufacturer has constructed a toaster with such narrow guards that they do not interfere with even browning. (Fig. 43.)

Heating elements are of two kinds: helically wound coils, and flat metal ribbon on mica sheets. Both coils and ribbon are wound more closely together toward the base of the unit in the side slice toaster, since the vertical racks slant outward slightly at the bottom to give the toaster balance and the lower half of the slice of bread is, therefore, farther away from the element. Occasionally coil elements sag with long use and give too hot a temperature at the bottom. The power rating of a toaster usually falls within a range of 660 to 1150 watts. Potter and Biller found that the toasting temperature was approximately 400° F. After a preheat period of 1 minute, an oven-type toaster should toast bread to medium brownness in 1½ minutes; a reversible type in 3 minutes. Length of time of toasting has an important bearing on the results and should be carefully watched by the operator.

Some toasters have an automatic device by means of which a lever may be set to indicate the depth of browning desired. The lever is controlled by clockwork, and when the toast is done it is lifted out automatically or the current shuts off. The control on different makes varies somewhat, but the

underlying principle is the same. In one model there is no clock, and the toasting is entirely controlled by the thermostat, which turns the current off and on as in an electric oven. The toast is not automatically removed and will continue to brown and dry out if left in the toaster. The control on another toaster may be set for "pop-up" toast, or, if preferred, it will allow the toast to remain within the rack and keep warm.



Sunbeam

FIG. 43. Various control devices on an automatic toaster. Note double thermostatic control.

One manufacturer supplies a thermostat mechanism that measures the actual temperature of the bread surface. As the bread browns, an increased amount of heat is reflected from its surface to the thermostat, which is activated to trip the pop-up device at the preset degree of temperature.

An automatic control prevents burned toast, but, in selecting a toaster with a control, it is well to inquire if it has been given a life test at some recognized testing laboratory. There should be a manually operated release in case the automatic device fails to work. Some automatic toasters seem to be lacking in precision and do not always produce toast of the same degree of browning, even at a constant setting. This may be caused sometimes by variation in voltage. Difference in browning may also be caused by a difference in the moisture content of the bread. In the experiments carried on by Proctor and Biller, the timer was found to be a better control device than the

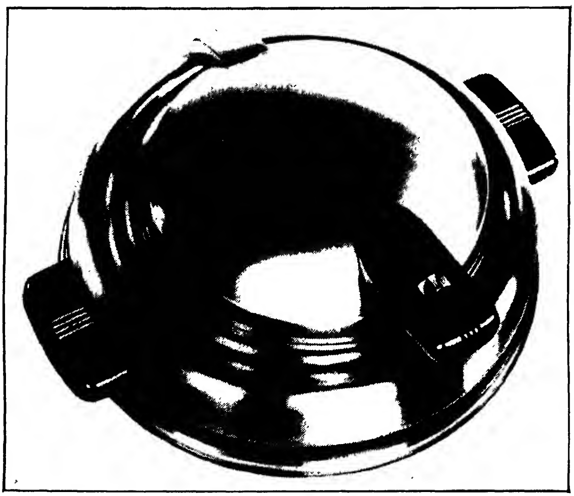
thermostat. Double thermostatic control is an arrangement claimed to prevent variation in browning and to produce toast of uniform quality regardless of the number of slices toasted. (Fig. 43.) Some means of keeping the toast warm is a desirable feature.

The present tendency is to buy baker's bread rather than to make bread at home. Sliced store bread has an average maximum size of about 4¼ by 4¼ by ½ inches, and toasters are built to hold slices of approximately this size. Slices of homemade bread are usually larger, and, when they are to be constantly used for toast, an appliance must be selected that will hold them.

Sandwiches may be toasted on the grill. The even heat from the solid plates melts and blends the sandwich filling. For best results the grill should be preheated. An appliance that may be used for more than one type of operation recommends itself to the thoughtful purchaser.

Waffle bakers

Waffle bakers—also called waffle molds and waffle irons—like toasters, are usually made of steel or copper plated with chromium or

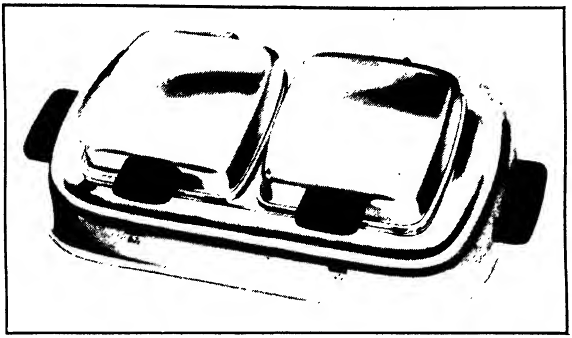


Westinghouse

Fig. 44. Waffle baker with dial controlling the thermostat mounted in the plastic handle. A signal light in handle indicates time to pour batter and remove waffle. Grids are pretreated and do not require seasoning.

nickel. (Fig. 44.) The baking grids are commonly of cast aluminum. The terminal studs, which should be protected by a guard, are on the

lower half of the baker, and connecting wires to the upper unit pass through the hinge. The wires must be carefully insulated from the

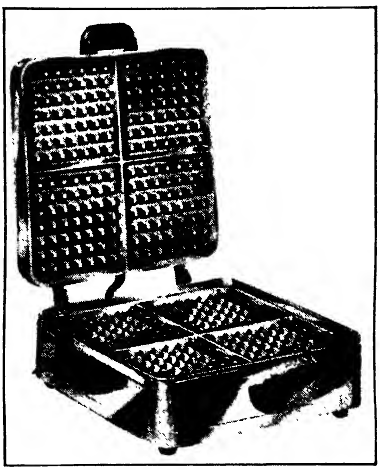


Westinghouse

Fig. 45. Twin waffle baker. Each side has individual heat selectors.

metal of the appliance and must be protected from injury in the opening and closing of the iron. At least one baker eliminates the wires through the hinge by having separate connections on the upper and lower grid.

There should be sufficient freedom of action in the hinge to allow the waffles to rise; otherwise they will be soggy. The tray of the iron should be broad enough to catch any drippings of batter, although an overflow rim on the edge of the lower grid is more desirable. All edges should be smooth, the bottom of the baker insulated to protect the table, and the handles made of heat-resistant material.



Sunbeam

Fig. 46. This baker makes four waffles at one time. Note that the grid knobs are high and close together and will produce a crisp waffle.

Depending upon the shape of the baker, waffles may be rectangular, round, or square. Twin irons are obtainable and also a baker that makes four waffles at one time. (Figs. 45 and 46.) The height and distance apart of the knobs on the grids apparently have a definite influence on the crispness of the waffle. Tests made in the household equipment laboratories at Iowa State College indicate that the higher the knobs and the

nearer together, the crisper the waffle. (Fig. 46.) A soft and more moist waffle is made in irons with shallow knobs farther apart.

The heating elements may be helical coils insulated with porcelain posts or hollow tiles, flat ribbons on mica sheets, or Calrod-type units. Elements have a rating of 660 watts to 1200 watts.

Many of the bakers have heat indicators to show when the preheat period is complete, and automatic controls to maintain a constant baking temperature. Sometimes different degrees of browning are possible. If no indicator or control is furnished, the correct temperature may be ascertained by inserting a piece of paper between the grids until it becomes the desired shade of brown. The average of a number of tests made on irons of different makes gave 3 minutes as the time for baking the first waffle, after the preheat period. In general, succeeding waffles required a slightly longer time, because of the cooling of the iron, unless the operator allowed the iron to heat a minute or two between bakings.

A tablespoon of batter to each section is the rule. The waffle should bake until steam ceases to issue from the opening between the grids. Grids should heat evenly, and all grids should heat equally well.

Electric waffle bakers need not be greased but must be seasoned before being used for the first time unless they have been seasoned by the manufacturer. Seasoning is accomplished by preheating the iron, brushing the grids with an unsalted fat, and cooking a first waffle until it becomes very brown. The fat seals the microscopic pores in the aluminum. After an iron has been seasoned, the waffles should not stick if the recipes contain melted fat (from 4 to 6 tablespoons). Do not wash the grids lest resealing be necessary. Brush out the crumbs and wipe with a slightly damp cloth. The brown film which may form on the grids does no harm to the waffles and prevents sticking. A steel wire brush will remove any excessive amount. Wipe off the nickel or chromium with a damp cloth and polish with a dry one. Discolorations on nickel may be removed with a mixture of alcohol and whiting.

Besides the ordinary plain waffle, many other varieties, such as gingerbread, chocolate brownies, biscuit dough, and also French toast, may be cooked on the iron.

It is a convenience if the terminals on percolators, waffle bakers, and toasters are of the same size and type so that connecting cords may be used interchangeably. Many cords, however, are now permanently attached. The modern trend is to manufacture waffle irons,

toasters, percolators, and grills matched in symmetry of design and decoration. It is even possible to obtain them with an individual monogram.

Egg cookers

The electric egg cooker has helped to take the guesswork out of cooking eggs in the shell. A lower compartment, wired with an electric unit, contains a rack for four eggs. After the eggs are in place, water is added—one, two, or three teaspoonfuls, depending upon the degree of hardness desired—the spherical cover is put on, and the electrical connection made. As the water boils steam issues from a small opening in the top of the cover; when it ceases, the eggs are done. Some cookers have an automatic attachment that shuts off the current when all the water has evaporated. In egg cookers the electrodes are frequently exposed. It is essential, therefore, to avoid touching the electrodes with the fingers or with metal utensils. The cooker should never be used near the sink or near other grounded metal. An extra pan may be supplied for scrambling or frying the eggs.

Food mixers

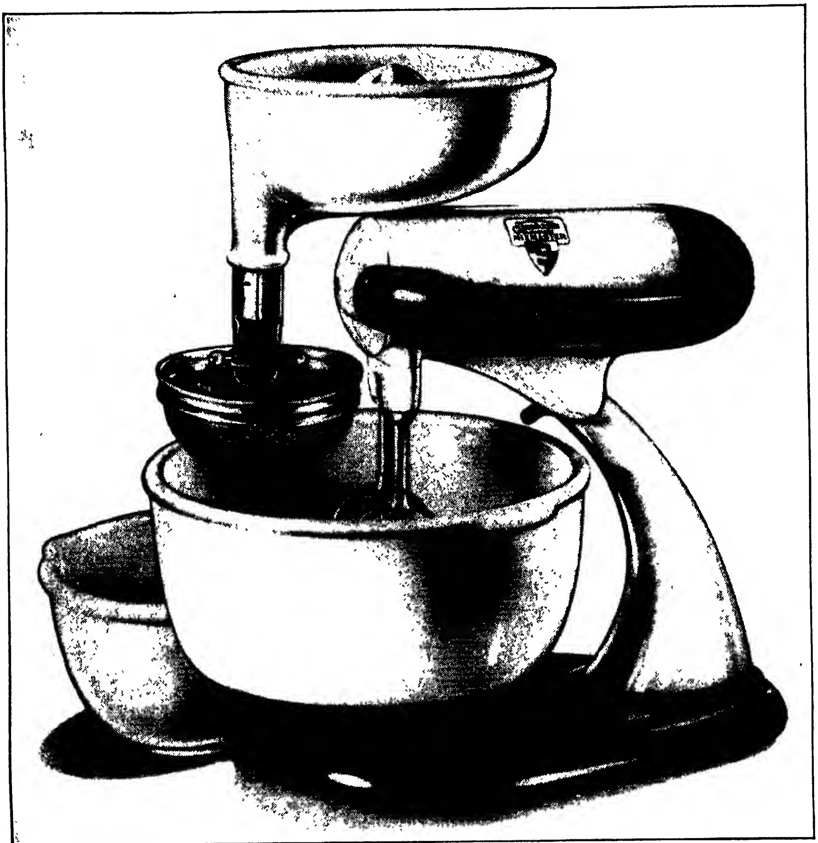
The small appliances considered so far have used electricity as a source of heat. Food mixers are motor-driven and use electricity for power. They should carry the seal of approval of the Underwriters' Laboratories for safety. Most mixers may be operated on either alternating or direct current.

There is a large variety of mixing machines and beaters: large ones with many attachments for all kinds of operations and small ones with one, two, or perhaps three attachments; mixers permanently fastened to a stand and mixers which may be removed from the stand and used at any place within reach of an outlet; mixers with a device for adjusting the height of the beaters to the bowl; beaters so well balanced that they stand upright without support and others that must be held even though the motor whirls the blades.

A manufacturer of one of the larger mixing machines has noted that "of the strictly mechanical operations carried on in the typical home kitchen approximately 60 per cent are performed in a bowl or receptacle of some kind, and are described as mixing, beating, whipping, stirring, folding in, creaming, kneading, etc." [1] The beater or whip is, therefore, the most important attachment of the machine.

[1] A Benevolent Robot, KitchenAid Manufacturing Co., p. 4.

Most of the beaters are of the wheel or circular type. Two wheel beaters, each consisting of two circular steel blades, are fastened to the shafts below the motor case and turn in unison. (Fig. 47.) One



Sunbeam

Fig. 47. The speed selector indicates the desirable speed for a given operation. The juicer attachment is also shown.

small beater has a flat agitator, a hollow oval with four fins which join the outer rim to the central shaft. A larger mixer has a whisk beater of many fine wires. The agitators may have a double motion, called planetary motion, in which the beater revolves on its own axis and at the same time rotatoes around the bowl; or the beater may revolve and the bowl itself turn as the platform on the base of the mixer rotates.

The bowl platform may have two fixed positions that place the beaters at the side or in the center of the bowl. In one model, however, the platform is adjustable to any point between the center and side. If the beaters are in the off-center position, the bowl rotates automatically whenever the batter is heavy enough to produce sufficient friction. In this way the entire contents of the bowl are brought into intimate contact with the blades and are thoroughly whipped or blended. Blades vary somewhat in size, are round or oval, and have a smooth, even surface or a central ridge which may be either concave or convex. The edges should be thin. The blades must not touch the bottom of the bowl but should just clear it. A flat metal pin fastened beneath one agitator or to the central support makes contact with the bowl and causes it to rotate.

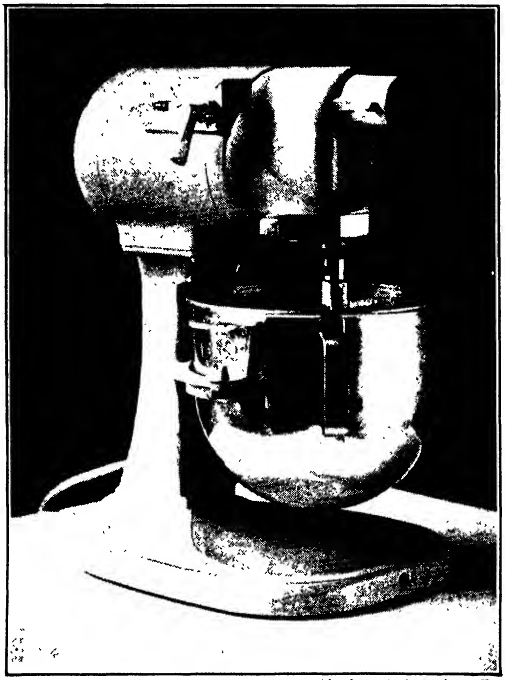
Beaters may be rotated at different speeds. Some machines allow for three distinct variations; low, medium, and high; others give a number of different speeds between low and high. In one mixer the speed selector is marked to indicate the desirable speed for different operations. In the smaller mixers the speed is usually controlled by a rheostat which varies, according to very definite proportions, the amount of current flowing to the motor and, therefore, the speed. In the new better-grade mixers the speed is controlled by a governor which maintains a uniform rate. A large machine also has a constant-speed motor and regulates the different rates by gears. (Fig. 48.) The control may be on the base of the mixer or on the housing of the motor. A lever turns the current off and on.

Bowls that come with mixers are commonly made of glass, but one mixer has bowls of tinned steel. Bowls that do not scratch or chip are to be preferred. The bowl is held in place by a supporting arm, by an adjustable clamp on the base of the mixer, or by the raised edge of the base. It should be easily removable for cleaning. In case of need, any ordinary bowl may be used with most mixers, but, in general, the shape of the bowl as well as the shape and size of the beater blades determine the efficiency of the action.

The beater blades may be removed for washing, or they may be rotated in a bowl of warm soapy water and then in rinse water. The motor should not be put into water. Follow the manufacturer's directions for oiling the motor. The right kind of oil, the right amount, and the frequency of oiling are important. Too much oil may be as injurious as too little. When there is a wick in the oil tube, it feeds the oil to the parts as needed, and there is no risk of overoiling. The

oiling system should be leakproof so that there is no chance of any dripping into the food. The motor housing and supporting pedestal and base are of enameled iron or steel, which may be wiped clean with a damp cloth. Rubber feet on the base prevent marring the work surface.

In purchasing, choose a machine with as quiet a motor as possible, one that is easy to operate and clean with the minimum of handling.



KitchenAid Mfg. Co.

FIG. 48. A large mixing machine in which the speed is regulated by gears.

Select a size in accordance with the need, and at a cost that is warranted by the family income.

A good mixer can save a lot of energy in food preparations which involve much beating. It can mix batters for cake, cookies, and quick bread, for waffles and pancakes; it can be used for making frostings and mayonnaise and for whipping mashed potatoes; it does an excellent job of beating eggs and cream. Difficulties and apparent failures may often be surmounted by modifying the recipe or the method of manipulation. There is opportunity for much valuable experimentation along this line.

Many of the inexpensive mixers on the market are quite incapable of doing anything more than stirring solutions. They are a poor buy—good for mixing drinks, perhaps, and for beating eggs, but they have very little other value. Their small motors tend to become overheated when used for mixing batters—they have insufficient power to overcome the friction.

A large mixing machine must be used very frequently or for a large amount of food to justify the money invested. It is not possible, however, to measure in dollars and cents the increased pleasure and satisfaction taken in work performed without the excessive expenditure of energy that many hand operations require.

The use made of a mixer will largely depend upon its availability. It should be connected to an outlet at the preparation center in a spot where it will rarely need to be moved. A cover of plastic material will keep it free from dust, is easily slipped off, and requires very little storage space. If the homemaker prefers to store the mixer in a cupboard it should be on a shelf that will swing out into position for use.

The juice extractor is very often an extra attachment on small mixers. (Fig. 47.) It is usually connected to the gear assembly through a power take-off separate from that which drives the beaters. Large machines and some small ones, too, have several other attachments: vegetable slicer and shredder, food grinder, oil dropper, and even an ice-cream freezer. To use some of these attachments an extra power unit must first be connected to the mixer.

Electric churns

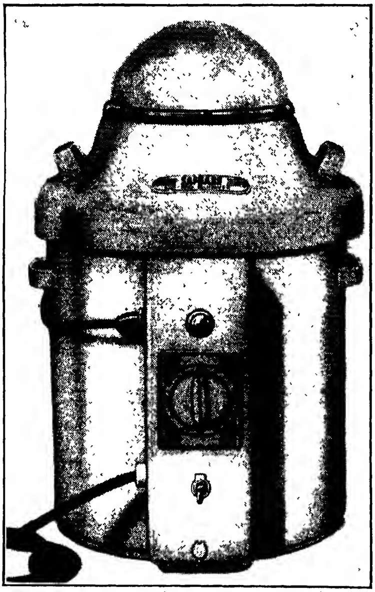
Electric churns are available for use in the modern farm home. The cream container may be of metal or glazed earthenware; the dasher is usually of hardwood. The dasher shaft is belt-driven by a $\frac{1}{6}$- to $\frac{1}{4}$-horsepower motor which may be mounted either above or below the supporting frame. Churns vary in capacity from 3 to 10 gallons. They cost from one and one-half to two times the price of the household mixer and should be used for all family churning to justify the money invested. One household mixer company is planning to manufacture a churn attachment for the mixer, which should be somewhat less expensive than the separate appliance.

Milk and cream home pasteurizer

The danger of contracting undulant fever, as well as other diseases carried by raw milk, has made a small pasteurizer a very necessary

appliance for families with one or two cows that furnish the home milk and butter supply. Heating milk in an ordinary pan on top of the range, without proper agitation, may give milk an undesirable half-burned flavor and may cause the cream to rise to the top in a curdled scum that cannot be stirred back into the milk.

In the home pasteurizer illustrated in Fig. 49, the milk is placed in an inner container, which is surrounded by an electrically heated water jacket. A motor-driven agitator keeps water and milk in constant motion during both heating and cooling periods. The agitation causes any undesirable odors to rise to the surface of the milk, where an air expeller pumps them out of the container. Temperature of the milk is automatically controlled at 143° F., the standard pasteurization temperature. The motor is a solenoid type, with only two slow-moving parts and no armature or brushes to wear or burn out. The motor uses less than 50 watts; the heating unit, 1250 watts. The heater, however, is in operation for only a short time.



Safgard, Guard-It Mfg. Co.

FIG. 49. Home pasteurizer.

Rapid cooling is accomplished by allowing cold water to flow through the outer shell while the agitators continue to operate. In this way milk and cream are cooled quickly and evenly.

The milk container is of tinned steel. The water jacket is also of steel finished with porcelain enamel on the inside to prevent rusting and a baked-on synthetic enamel on the outer surface. This home pasteurizer may be operated on any 110–120 volt, 60-cycle alternating-current circuit.

OTHER SMALL ELECTRICAL APPLIANCES

Other small electrical appliances include bottle warmers, immersion heaters, fans, corn poppers, etc. Information on any of these, and other appliances not discussed in the chapter, may be obtained from

the manufacturers, from local merchants handling the appliance, or from the testing institutes of certain magazines.

All reliable appliances have a name plate indicating whether they are to be used on alternating or direct current, the voltage for which they have been wired, and the power that will be used. To avoid possible injury to the appliance and to obtain most efficient results, the requirements on the name plate should be complied with.

Consultation with the local power company will often be helpful to anyone considering the purchase of equipment involving the expenditure of a considerable amount of money. Usually such companies handle makes of appliances that they themselves have tested or in regard to which they have definite information from other reliable sources. When they do not merchandise appliances, they should be able to give the purchaser unbiased advice and suggestions.

Summary

1. In selecting small electrical equipment, consideration must be given to durability of construction, ease of operation, kind of product obtained by the use of the appliance, and ease of cleaning.
2. On these four points, electric roasters, table stoves, grills, percolators, toasters, waffle bakers, egg cookers, mixers, churns, and home pasteurizers have been discussed.

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5

The Electric Range

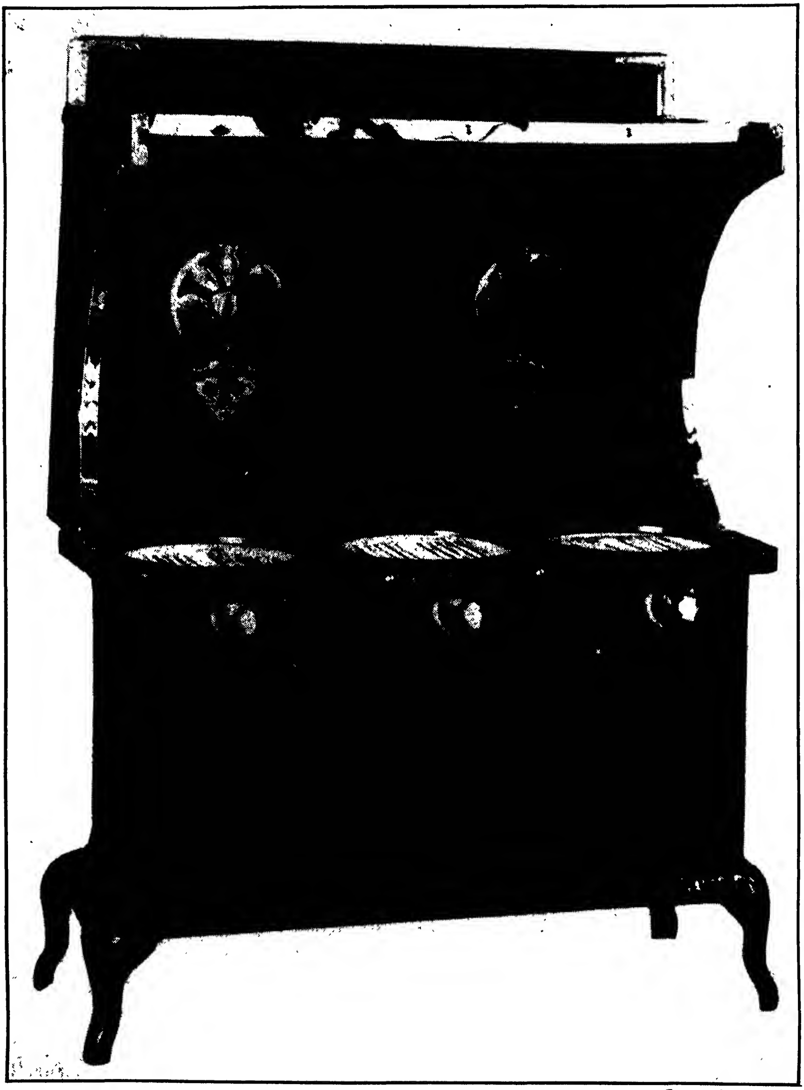
THE IMPORTANCE OF SELECTING an electric range that is well constructed and that meets the needs of the individual home is recognized, but, with electric ranges manufactured by a number of companies and each company manufacturing several models, the problem of selection is at best a perplexing one.

Design

During the past few years the design of electric ranges has changed rapidly. The early range resembled the coal and wood stove, with the low oven and overhead warming shelf. (Fig. 50.) Then came the high side oven, which eliminated stooping. This design was known as the conventional-type range. With the modernization of the kitchen, the high oven was gradually lowered until today practically all ranges are of the table-top type. (Fig. 51.) This design has been so designated because the entire top of the range is on a level with the kitchen work tables and provides continuous working surfaces.

With the relatively accurate temperature control possible in the modern electric oven, "time-temperature" cooking has eliminated the watching of food. The development of easy-sliding, lock-stop shelves, which remain practically level when pulled out, has decreased the necessity for stooping. These factors along with the added advantage of an increased working surface have largely overcome the early objections to the table-top range. Although the high oven has become a discontinued design, some women still prefer it. One manufacturer is constructing the surface unit and oven as separate appliances. The surface units are designed to be built into the counter top of the work tables while the oven can be built into a floor-to-ceiling cabinet. The cabinet for the oven usually adjoins the work tables and makes possible continuous working surfaces as well as the placement of the oven at any desired height.

Table-top ranges are of the cabinet type. They are built to the floor and usually provide extra space for warming drawers or storage. The base of the cabinet is recessed at the front for toe space. (Fig. 51.)

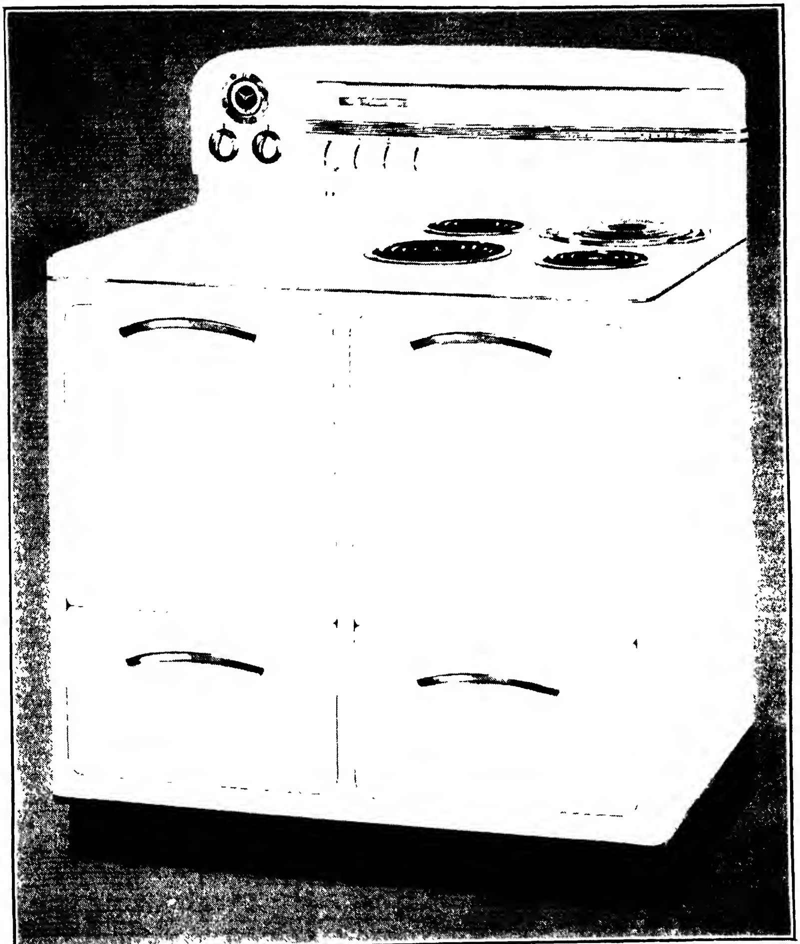


General Electric

FIG. 50. The first successful electric range, built in 1910 by George H. Hughes.

SIZE

Table-top ranges may be obtained in two sizes, the apartment range and the standard range. The apartment range has three or four sur-



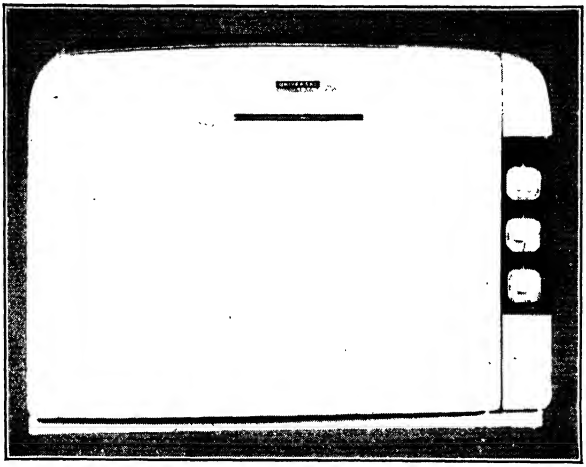
Westinghouse

FIG. 51. Table-top cabinet-type range.

face units with one oven directly beneath. This range is compact in construction, rarely occupying a floor space greater than 21 by 25 inches. The apartment range is equipped with a standard-size oven and standard surface units. Because of its size and the elimination of many special features usually found on standard ranges, the apart-

ment range is the cheapest of all models in any given line. This type of range is used largely in kitchens where floor space is limited and in low-cost housing.

The standard range is approximately 25 inches in depth and is available in lengths varying from 36 to 60 inches. However, the majority of ranges manufactured are from 38 to 40 inches in length. Ranges are equipped with three or four surface units and with one or two ovens. The four-unit one-oven range, however, is the most com-



Landers, Frary and Clark

FIG. 52. This small electric range can be attached to a convenience outlet.

mon. The surface units may be spaced over the entire range top, grouped in the center, placed at one side, or divided with half on one side and half on the other. In a one-oven range, the oven may be either at one side or in the middle.

In addition to the apartment and standard range, a portable type is available which may be attached to a convenience outlet. This range has one or two surface units of low power and a small oven. In portable ranges the surface units are usually on top or at the side of the oven. In one design the oven unit is an embedded coil wrapped around the oven lining while the two surface units are mounted on a separate steel frame. These are connected at the bottom level of the oven for surface cooking and at the top of the oven for broiling. Portable ranges of this type have definite load limitations, depending on the condition of the house wiring. Ranges to be used on new wiring are limited to 1650 watts; those to be used on existing wiring are limited to 1320 watts. This low power means that the oven and

both surface units cannot be operated simultaneously. The portable range is best suited for use in a light-housekeeping apartment or in a summer cabin. (Fig. 52.)

Construction

For the sake of convenience in the study of its construction, the electric range may be divided into five parts: the frame and exterior surfaces, the surface units, the oven, the switches, and the appliance outlets. Some special features are usually found on most ranges.

Frame and exterior surfaces

The frame and base of an electric range should be of strong and durable material. Enameled iron and sheet steel are commonly used. Sheet steel is used almost universally for the side and top surfaces. In most present-day models, the entire body is constructed of one piece of heavy-gauge steel reinforced by welded steel supports. This method of construction affords greater rigidity and eliminates unsightly bolt heads formerly used in fastening porcelain panels. It also provides for a more uniform porcelain enamel finish and makes the black wipings unnecessary. Because of the more rigid body, chipping is less likely to occur in the porcelain finish.

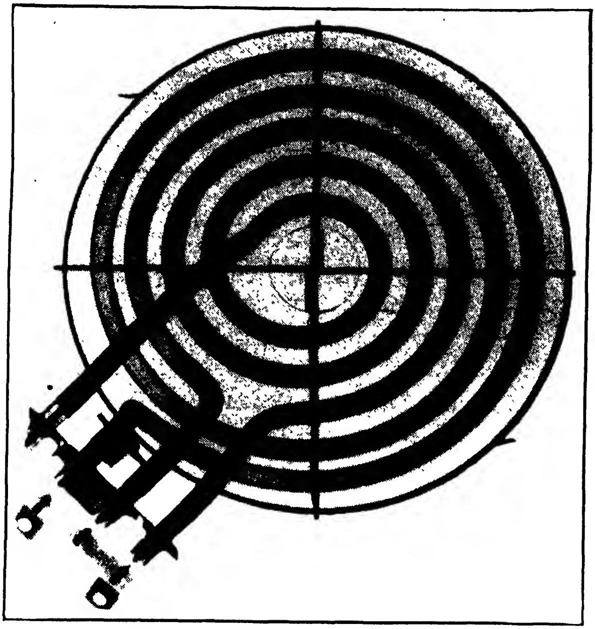
Exterior surfaces and oven linings are finished in porcelain enamel. The cooking work surface is of acid-resisting enamel, which prevents spotting and objectionable staining by food acids. Interior finishes, such as drawer and compartment linings are of porcelain enamel or baked-on synthetic enamel. Trims are of enamel, plastics, and chromium plating. Enamel is more practical as it does not require mechanical fastenings and is easier to clean. Hinges should be made of a good grade of steel or malleable iron finished so it will not rust. Switch buttons and drawer and oven handles should be of a material of low thermal conductivity. Plastic materials are commonly used, although a few de luxe ranges are all metal.

Surface units

Surface units for electric ranges are available in several different types. These are known as the tubular, ring, open, and cast-in types.

Tubular type. The tubular-type surface unit is used on most current models of electric ranges. In this unit the element consists of a heating coil of nickel-chromium wire encased in a metal tube. (Fig. 53.) The nickel-chromium wire is insulated from the tube with magnesium oxide powder firmly packed around the coil. The unit is

made up of one or two tubes bent in spiral form and held in position by radial supports. The coils and supports are mounted in a metal reflector pan. This pan is usually removable for cleaning. (Fig. 54.) In the two-tube unit, the tubes are anchored to the radial supports to help prevent their warping out of line with each other. In using this unit, care must be observed to keep the tubes in position. If one



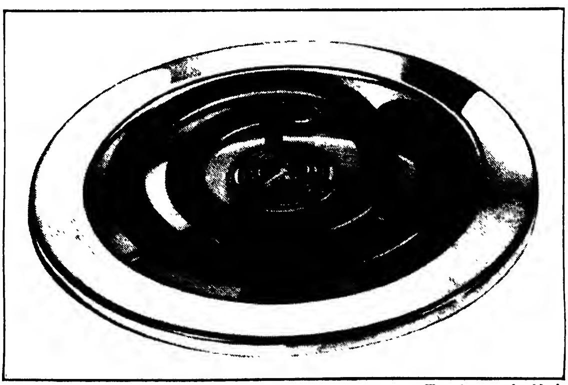
General Electric

FIG. 53. An x-ray photograph showing the construction of a two-coil tubular-type unit.

tube slips out of place, maximum contact between unit and utensil is destroyed. In the single-tube unit, known as the "Monotube," no anchorage is needed. (Fig. 55.) This construction insures more constant contact between unit and pan. This unit uses a clamp-and-bracket assembly that allows the single tube to be lifted vertically out of the way for easy cleaning of the pan. The top surface of the metal tubes is flat to provide for good thermal contact with heating unit and cooking utensil. (Figs. 53 and 55.) The tubular-type unit has low thermal mass and heats largely by conduction. Most efficient results are obtained by using a pan made of a material having high thermal conductivity and constructed with a flat bottom, so as to give maximum contact with the unit.

Hotpoint

Fig. 54. An easily removed metal reflector pan.



Tuttle and Kift

Fig. 55. A one-coil tubular-type surface unit.

Open units. The open unit commonly used on the early models of electric ranges is no longer found on present-day ranges except in the insulated cooker. The open-labyrinth type of unit consists of a

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Fig. 56. An open-labyrinth surface unit (double-spiral type).

molded disk of unglazed pottery with one or two labyrinth grooves in the upper surface for heating coils. (Fig. 56.) This type of unit

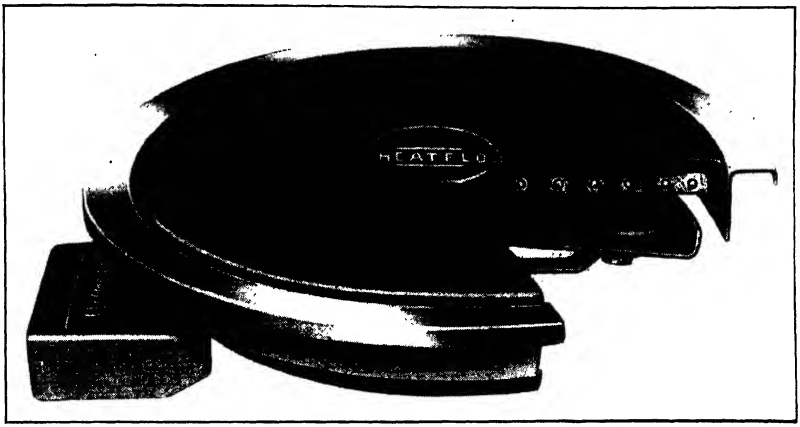
Edwin L. Wiegand Co.

Fig. 57. Cross-sectional view showing construction of ring-type unit.

transfers its heat largely by radiation, hence the speed of heating and the efficiency of the unit are noticeably affected by the nature of the bottom of the pan used. The thermal mass of the unit is higher than

that of the tubular type, the life of the coil is shorter, and the unit is more difficult to clean than other types. For these reasons, the open type is no longer used for surface units.

Ring type. The ring-type unit consists of two or three concentric flat rings, each made of two thin sheets of metal. Between the two sheets of metal forming each ring, the heating element is embedded in an electrically insulating material. (Fig. 57) The concentric rings are mounted in a metal ring with a metal reflector base. This unit



Edwin L. Wiegand Co.

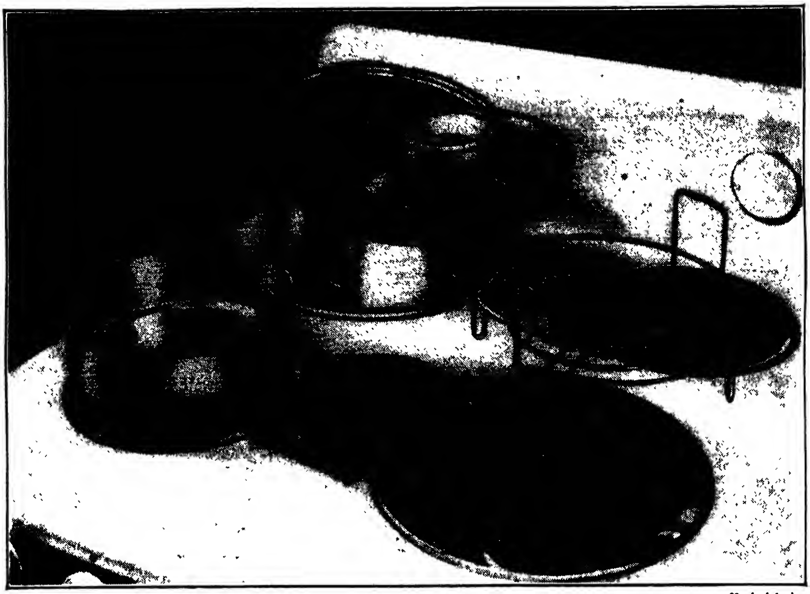
FIG. 58. Cross-sectional view showing construction of cast-in type of surface unit.

has slightly higher thermal mass than the tubular type but considerably less than the open unit. It transfers heat largely by conduction. Ring-type units were also used on early ranges, but on current models they are replaced by the tubular type. At the present time the ring-type unit is manufactured only for replacement of existing units.

Cast-in type. In the cast-in unit the electrically insulated coil is cast into a metal disk. (Fig. 58.) This type of unit has high thermal mass and is slow in heating but holds the heat well. It is used largely in low-priced ranges.

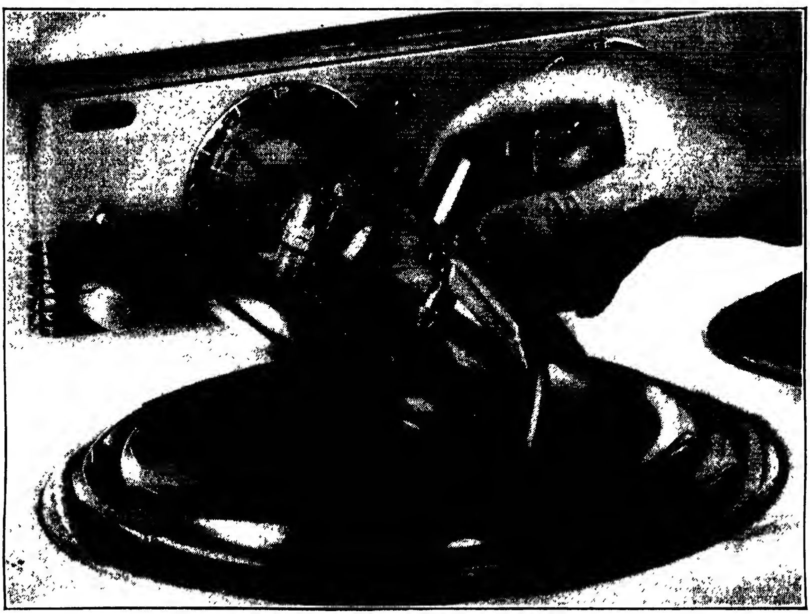
INSULATED COOKERS

Most standard ranges, and a few apartment ranges, have as standard equipment three surface units and an insulated cooker. The cooker consists of an insulated well equipped with a metal inset pan with a tightly fitting lid. The inset pans range in capacity from 5 to 7 quarts. Many cookers are also equipped with a trivet and a deep-



Frigidaire

Fig. 59. Insulated cooker fittings.

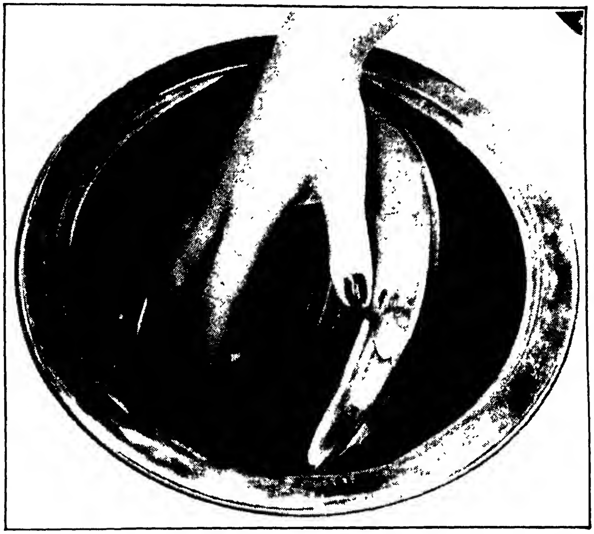


General Electric

Fig. 60. A pressure saucepan designed for use in an insulated cooker well.

fat frying basket. Others provide sets of double and triplet inset pans and baking racks. (Fig. 59.) The newest developments in insulated cookers are a pressure saucepan that fits into the insulated well (Fig. 60) and a unit that can be raised from the bottom of the well to the surface to give a fourth surface unit. (Fig. 61.)

Open-, tubular-, and ring-type units are used in insulated cookers. The tubular type is usually used in the lift-up units.



General Electric

Fig. 61. Lift-up type of deep-well cooker unit that can be raised to top of well to provide an additional surface unit.

The power used, the heats furnished, and the method of wiring the cooker units vary with different manufacturers. The power ranges from 660 to 1200 watts, and the heats furnished may be three, five, six, or an unlimited number. In some cookers the heating element is in the bottom of the well; in others it is wound around the walls. The coils in the heating element are unequal in resistance so that very low heat is obtained on the lowest position of the switch.

The insulated cooker is known by a number of trade names, such as utility cooker, economy cooker, and thrift cooker. These names have been applied because of its general utility and economy features. It can be used for steaming, boiling, deep-fat frying, and sterilizing. Whole meals may be cooked at one time. Vegetable platters may be steamed without mingling of flavors, and tough cuts of meat which require a long low heat may be prepared at very low cost. In the

five-heat higher-power cookers, the highest heat provides for the rapid starting of food, deep-fat frying, and browning. Intermediate heats usually maintain frying temperatures, provide for vigorous boiling or steaming, sterilizing, and pot roasting. Low heat ordinarily maintains steaming whereas warm heat is sufficient for overnight cooking of cereals, fruits, and tough cuts of meat.

In some cookers, a safety-type switch is provided to protect the aluminum kettle if the switch is accidentally turned on or the cooker allowed to boil dry. One manufacturer offers a switch designed so that the operator sets it for the number of minutes needed on high heat, and it automatically turns to low heat at the end of this time. In another design the cooker is thermostatically controlled, whereas in still others the cooker can be time controlled.

In addition to the above standard units, one manufacturer makes a unit that consists of an insulated stainless steel well, with the heating element wound around the sides and across the bottom. The unit is controlled by a four-position switch. The first position turns full power on both sides and bottom. The second position is for frying operations with high bottom heat. In the third position one-fourth the full power heats both sides and bottom for long, slow cooking. A utensil for use in the well is supplied by the manufacturer.

Metals used for heating elements

The wire used in electric-range units is made of nickel chromium. It is sold under such trade names as Nichrome, Chromel A, and Karma. Nickel-chromium wire maintains a uniform resistance with a minimum variation and will withstand continuous high temperatures.

Wiring of range units

Standard range units have five, six, seven, or an infinite number of heats. Most units have two 236-volt coils. For high heat they are connected in parallel across the 236-volt circuit. If the coils are equal in resistance, the next two lower heats are usually obtained by using one coil across 236 volts and by connecting the two coils in series across 236 volts. If the two coils are unequal in resistance, the next two lower heats are sometimes obtained by using each coil singly across the 236-volt circuit. The two or three lowest heats are secured by different connections of the coils across the 118-volt circuit.

The most recent development in surface units is a motor-driven switch that provides for an infinite number of heating speeds, rather

than the customary five, six, or seven heats of the conventional type. In this type of unit only one coil is used.

Diameter of surface units

Most electric ranges are equipped with two sizes of surface units. The small unit varies from 5½ to 6 inches in diameter; the large unit is approximately 8 inches in diameter.

Power capacity of surface units

The power capacity of surface units varies from 660 to 2200 watts. The most common are 1000, 1200, 1250, 1300, 1500, 1750, 1800, 2000, 2100, and 2200.

High power is essential for bringing food quickly to the boiling point, but, when a boiling temperature has been reached, the only heat necessary, in addition to the heat needed to maintain boiling, is that which must be supplied to equalize the losses from the sides and top of the pan.

Three-unit ranges are designed for the use of one large-diameter high-power unit and two small-diameter lower-power units. Four-unit ranges may have one of the following combinations: (1) one high-power unit, two low-power, and an insulated cooker; (2) one high and three low; (3) two high and two low.

Factors affecting the speed of heating of surface units

In a study of the effect of construction of surface units on boiling time, it was found that all units transfer a portion of the heat by radiation, the open unit ranking highest; that the enclosed unit transfers the major portion of heat by conduction; that the speed of heating with the open unit is more affected by the material and finish of the pan than are the enclosed units; that enclosed units having low thermal mass heat most rapidly but do not hold the heat as long as open units of high thermal mass; that heat stored in units of high thermal mass increases the speed of heating from a hot start. In units of high thermal mass it is found that sufficient heat is often stored so that the current may be turned off for the last 10 to 15 minutes of the cooking period.

Comparative life of electric units

The enclosed types of units are of longer life than the open type. Although nickel-chromium wire oxidizes rather slowly under normal

conditions, the rate of oxidation increases when the wire is heated in contact with air, and the wire gradually disintegrates, thus decreasing the diameter of the heating coil. This shortens the life of the coil; also, the heating element in the open unit can come in contact with dirt, grease, and spilled foods. Certain foods burned on to the coils may cause a short circuit that will burn out the element. In the enclosed type the rate of oxidation is retarded during heating since the wire is not in contact with air. This increases the life of the unit. In early ranges, the life of the heating unit was an important factor. With present-day ranges this problem no longer exists. The life of the tubular-type units, even with their high speed and high efficiency, has proved so long that failure of surface units is very rare.

Ovens

The number of ovens and the size and placement are matters of personal choice, but the general construction, lining, insulation, units, and features of convenience may have an important effect upon the efficiency of the oven and will be considered in detail.

The construction of an electric oven is somewhat different from that of a fuel oven. Heat is supplied to the oven by an electric heating element. As there is no combustion making air circulation necessary, the heating element can be placed directly within the oven. In consequence, the oven may be practically airtight and may be heavily insulated for the purpose of utilizing stored heat.

The frame of the oven consists of four parts: the outer walls, the inner walls or lining, the insulation, and the door. The outer walls have been considered in the section on exterior surfaces.

Lining

The inside walls or lining should be of a material which is rust resisting and durable. Porcelain enamel on steel is used in practically all domestic ovens because it will maintain a good surface and appearance throughout the life of the range. Dark blue, speckled with white, is the predominating color, although a few are plain blue. Dark blue enamel is the first coat applied to the steel; it has a coefficient of expansion approximating that of the base metal. Furthermore, its thickness can be held to a minimum. As a result, the dark enamel will not chip as readily under the oven heat as will the outer lighter coats. Light-colored enamels also require constant care, whereas dark surfaces do not show soil readily.

Theoretically, bright, shiny metals should be more efficient for oven linings than are the enamels. Highly polished metals, however, discolor with use, owing largely to the intensity of oven heat, and decrease rapidly in efficiency. Porcelain enamel linings, even though soiled, retain their efficiency and are much easier to care for than metal linings.

Oven linings should be vaportight to prevent food vapors and moisture from penetrating the insulation. Moisture diffusing between the walls of the oven not only decreases the thermal insulating efficiency of the insulation but also has a tendency to cause the oven lining to rust, and if volatile food vapors penetrate the insulation they not only will decrease the insulating qualities but also will produce undesirable odors that cannot be removed. Moisturetight linings are secured by stamping the entire lining out of one piece of metal or by welding together the several pieces of metal used. Openings in the lining for the thermostat, oven vent, and terminals for the units should be fitted with vaportight bushings to prevent leakage at these points. For the same reason the lips or flange of the lining at the door should extend beyond the door frame. In better-quailty ranges both sides of the oven lining are porcelain enameled to prevent rusting. To facilitate cleaning, oven linings are usually made with smooth rounded corners, and the rack supports for the shelves are built into the side walls of the liner.

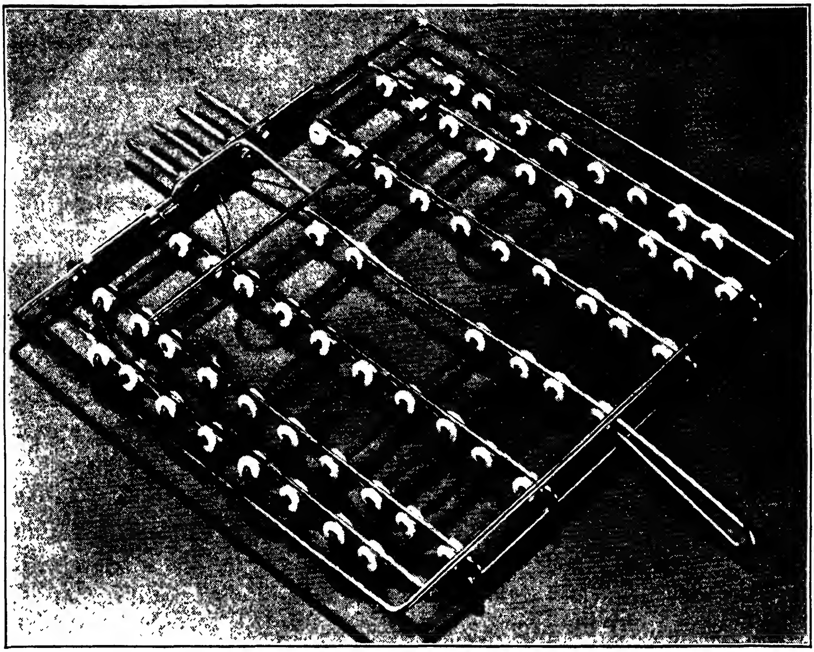
Insulation

The insulating materials most commonly used in electric ranges are mineral wool and glass wool. They are used in two forms, in flexible blankets and in bats cut to fit the walls of the oven.

Oven units

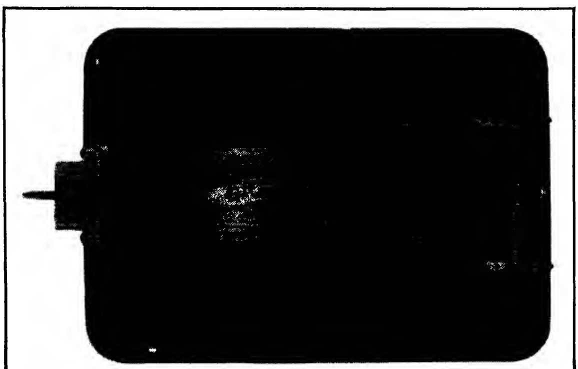
Most electric ovens have two units. The bottom unit is used for baking, and the top unit, as a rule, for broiling. In one-unit ovens either the unit is placed several inches above the bottom of the oven to provide for broiling below or a second terminal block is provided in the upper portion of the oven. A few ranges have separate broiling compartments.

Oven units are of two types: the open-coil type, mounted by means of small insulating supports on a metal frame (Fig. 62) and the tubular type of enclosed unit (Fig. 63).



Westinghouse

FIG. 62. An open-type broiler unit.



General Electric

FIG. 63. A tubular-type broiler unit.

The total power capacity of electric ovens varies from 1320 watts in the small portable ovens to a range of 2700 to 5400 watts in the standard-size oven.

No standardized method of wiring oven units has been adopted. In some ovens each unit is composed of a single coil, and the coils may or may not be equal in watts. As a rule, in this type of oven both units are used for preheating, the top unit for broiling, and the bottom for baking. In other ovens the top unit contains more than one coil. For preheating, all, part, or none of the top coils may be connected with the bottom coil. For broiling, all of the top coils may be used or only part. For baking, a portion of the top unit is connected with the bottom unit to give what is known as "balanced or equalized heat." Several manufacturers connect the two units so as to provide two broiling temperatures and two baking temperatures.

In most ovens the units are attached within the oven and are easily removable for cleaning and repair. In one range where the units are permanently attached, the bottom unit is hinged and lifts up for cleaning. In another range the bottom unit is sealed below the oven lining. This makes removing of the unit for cleaning unnecessary and cleaning of the oven easier. The frame on which the heating coils are mounted should be sufficiently rigid to prevent warping. It should also be made of a material that will not rust or oxidize in service. Aluminum-coated sheet steel is quite commonly used for unit frames.

Heat distributor

In the electric oven the heat transfer is by radiation and convection currents. Most manufacturers use a metal sheet over the bottom unit, which has been scientifically designed to direct the convection currents and spread the radiant heat uniformly throughout the oven. This metal sheet is known by such names as baffle, deflector, evenizer, and heat evener. In some ranges the heat distributor is fastened to the bottom unit; in others it is separate and removable.

The design of the distributor is dependent upon the type and size of the oven and upon the kind of unit used. When it is of the removable type the "top" and "front" are usually marked, and care should be taken always to replace it properly. If not properly placed in the oven the even distribution of heat may be destroyed.

In some ranges the bottom unit is recessed in the oven lining and a heat distributor is placed over the unit, flush with the open oven door. The top unit is usually not baffled unless the outer section of the unit is connected with the bottom unit for baking. With this type

of wiring a baffle is occasionally provided for the outer portion of the unit.

Shelf supports and shelves

In most electric ovens the shelf supports are an integral part of the side walls of the oven liner. This provides for easier cleaning, more rugged rack support, and fewer parts to remove. In a few ovens the shelf supports are of separate construction and held in place by lugs welded to the oven liner. If of the separate type, the racks and their supports should be made of non-rusting metal and the supports should be removable for cleaning. The shelves should be made of non-rusting heavy-gauge wire or wire with rust-resisting finish and should be of sufficient rigidity not to warp or sag.

Sliding shelves should be designed with a locking device to prevent dropping or tipping. Some shelves are constructed with a non-spill rail at the back and some are of the offset reversible type, designed to provide for two heights with one rack.

Broiler pans

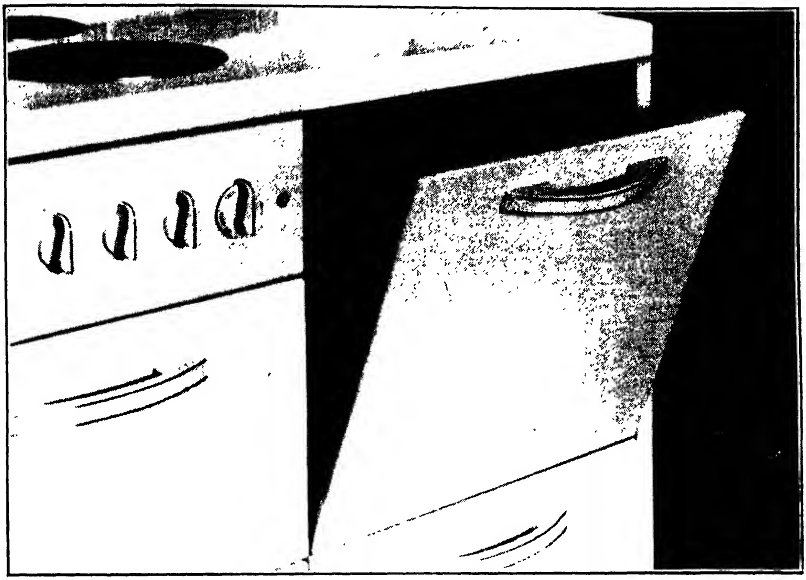
Broiler pans are usually made of porcelain enamel or of aluminum. They are equipped with a wire rack or grid support that holds the food off the bottom of the pan. The rack or grid provides space for the fat or extracted juices from the food to drip into the pan below. In this way liquids are removed from the intense heat of the unit, thus decreasing the smoking. One manufacturer provides a broiler pan with the bottom rounded to fit the large surface unit, so that it can be used interchangeably on the surface and in the oven. When the pan is used for roasting it may be moved to the surface for making the gravy.

Nickel-plated steel is usually used in wire racks, whereas grids are of sheet or cast aluminum or porcelain enamel.

Door

Oven doors should be well insulated and designed to fit tightly to minimize heat losses. Most manufacturers allow a maximum clearance of around $\frac{1}{16}$ inch at the bottom, with considerably less at the top. Oven doors are hinged either at the bottom or at the side. The bottom-hinged type forms a shelf on which food may be placed, and consequently is considered more useful than the side-hinged type. In some kitchens, however, the side-hinged door conserves needed floor space.

Most modern ranges use a concealed oven-door latch. By means of a positive cam action, the door is closed with a definite tension, providing a close door fit. The door should be counterbalanced so that it will remain fixed in any position. For maximum convenience there should be a positive stop position for broiling, 2 to 3 inches from the entirely closed position. (Fig. 64.) This provides circulation of air



General Electric

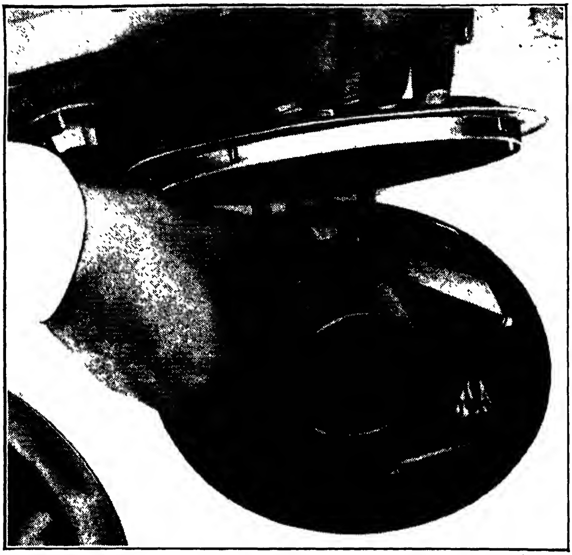
FIG. 64. A door with a counterbalancing spring.

at all times. Consequently, meats can be seared or grilled from the intense heat of the broiling unit instead of baked throughout, which would result if broiling were done with the door completely closed.

VENT

A vent in an electric-range oven provides for the escape of steam. The vent should be so located on the oven that hot vapors will not flow directly against the kitchen wall, since such vapors produce discolorations that are difficult to remove.

One arrangement provides for the oven vent to open into the reflector pan of a rear surface unit. This prevents the hot vapors from coming in contact with the wall. By lifting the reflector pan the vent can be easily removed for cleaning. (Fig. 65.)



General Electric

FIG. 65. A concealed oven vent that discharges vapors away from kitchen walls.

THERMOSTATS

Electric-range ovens are equipped with automatic oven-temperature regulators. Although there are several different designs of thermostats, they all depend upon the expansion and contraction of some material placed in the oven. The thermostat used by the large majority of manufacturers is of the hydraulic type, operating on the expansion and contraction of a liquid in a copper bulb or tube. The bulb of liquid is placed in the oven, and as the liquid expands it presses against a bellows or diaphragm, that in turn expands laterally, causing a switch to open the circuit. As the oven cools, the liquid contracts, thus permitting the switch to close the circuit.

The dial of the temperature control is usually located on the switch panel. This panel may be on the front of the range or on the backsplash.

In some ranges the thermostat dial and oven switch are combined in one. The most recent design of this type of control has an "off" and "broil" position in addition to the degrees of temperature. To preheat the oven, the dial is set at the desired temperature, which automatically turns on both top and bottom units. When the oven has reached the preheat temperature the current is turned off. After the first "off" period, the thermostat cycles from then on with only the

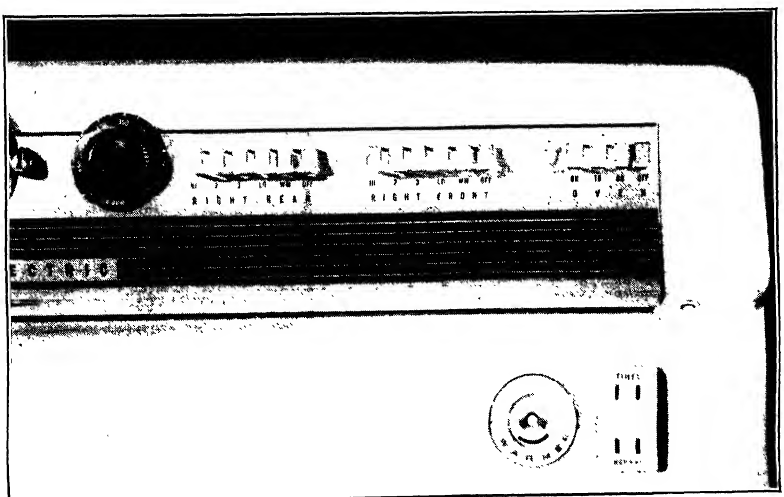
bottom unit in the circuit. This eliminates having to turn the oven switch from "preheat" to "bake." When the dial is turned to "broil" the coils used for baking are thrown out of the circuit and the top or broiling unit is connected into the circuit.

All ovens are equipped with a pilot light which glows when the oven is heating and goes out when the oven has reached the desired baking temperature. This may be a part of the thermostat or remotely located. In some ranges two lights are used, one to show when the oven is in the "broil" position and the other when it is in the "bake" position.

The calibration of the thermostat is important. Although thermostats are carefully constructed and calibrated in the factory, it is possible for them to be thrown out of adjustment in shipping. When a range is installed it is advisable to have the accuracy of the thermostat checked and adjusted if necessary. The thermostatically controlled oven has helped to change the process of baking from guesswork to an accurate science. Automatically controlled heat eliminates failures in oven cookery due to incorrect temperatures and does away with the necessity of watching food while baking.

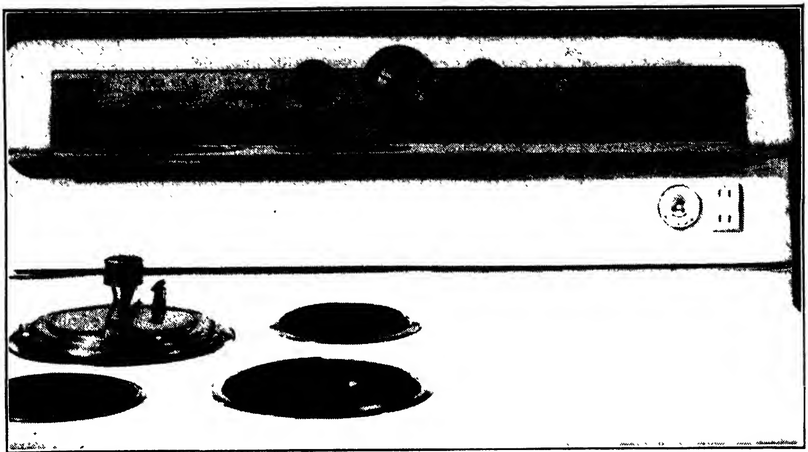
Switches

Most surface units are controlled by rotary switches which have several positions, the number depending upon the number of heats to



General Electric

Fig. 66. Push-button switches for the control of oven and surface units.



General Electric

Fig. 67. A high backsplash provides for the location of switches, thermostats, time clock and oven pilot indicators at shoulder height for maximum visibility.

Frigidaire

Fig. 68. De luxe range with insulated cooker, warming and storage drawers, oven signal lights, automatic time signal, and fluorescent cooking-top lamp. Switches for surface units on front of range.

be supplied by the unit. The manufacturer usually designates the position of the switch on the switch dial. The method of designation varies with different manufacturers. Some use numerals; others use words. Oven switches vary in design, most of them being of the rotary type. In many ovens the units are controlled by a single switch; in others the switch and the thermostat are combined. Methods of marking the positions of the oven switch also vary with different manufacturers. For the single oven switch one of the most common methods of marking is "off," "preheat," "bake," and "broil." One manufacturer uses push-button switches for both oven and surface units. A push button is provided for each position of the switch with the marking directly below it. (Fig. 66.)

The range switches should be placed at a convenient height. Some manufacturers prefer the front of the range; others use the backsplash over the oven. (Figs. 67 and 68.)

Convenience outlets

Most electric ranges are equipped with one or two convenience outlets. These outlets are usually located on the switch panel either on the front of the range or on the backsplash. They not only increase the number of appliance outlets in the kitchen but also make possible the use of small appliances on the work surface of the table-top range.

In some de luxe models the appliance outlet may be controlled by the time clock, which is an added convenience.

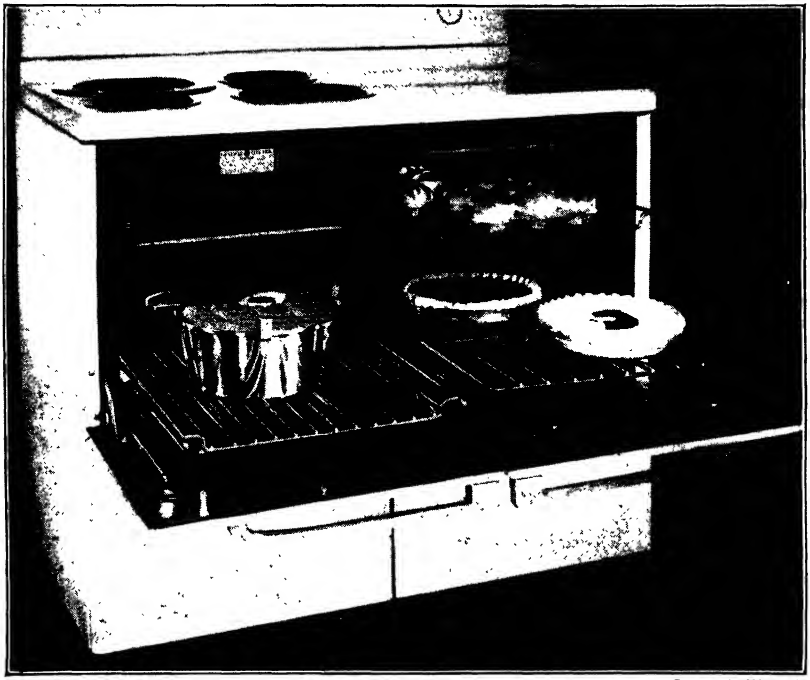
Since the appliance outlet furnishes current for small appliances it is connected across one of the 118-volt circuits of the range. The outlet circuit is fused with a 15-ampere fuse. The receptacle for the fuse should be readily accessible for convenience in replacing.

Special features

Many features which were formerly available only as accessories are now standard equipment. Insulated cookers are standard on practically all models. Storage compartments, an oven light, and pilot lights, both for oven and individual units, are found on many models. Platform lights, electric timers, minute reminders, warming drawers, separate broiling compartments, master pilots, illuminated oven dials, and condiment sets are ordinarily found on de luxe models. A few manufacturers provide de luxe models with two ovens. (Fig. 69.) Timers and minute reminders can usually be purchased with any model at extra cost. Some manufacturers include numbers on the

units and labels on the switch knobs for convenience. Others label only the switch knobs.

One manufacturer provides a window on the oven door, which enables the user to observe the food while it is cooking. Another



General Electric

FIG. 69. Double-oven range which provides for simultaneous baking at two temperatures.

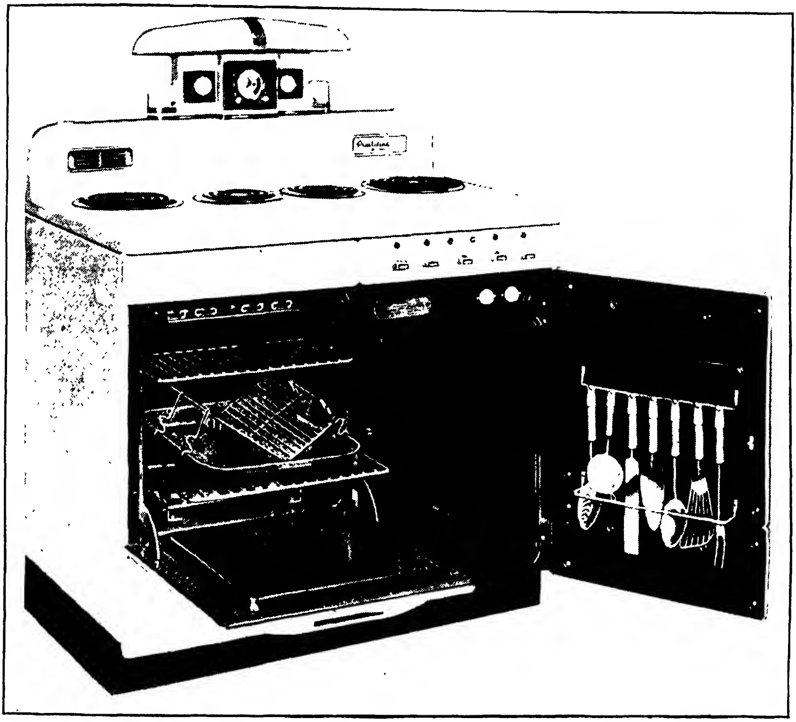
gives special emphasis to a functionally designed utensil storage compartment. (Fig. 70.)

TIME CONTROL AND MINUTE REMINDER

The time control is a mechanical or electrical clock that may be connected into an electric circuit to control the current. Different manufacturers use slightly different types of construction in the control, but the principle of operation is the same. In the newest designs, the timer is provided with movable dials with figures on them. These are rotated to set the "on" and "off" positions. (Fig. 71.) In setting the time control, the clock is connected into the circuit of the unit to be controlled, the dials are set to the hours at which it is desired to have

the current turn on and off, the unit switch is turned on, and the clock automatically makes and breaks the connection at the hours designated.

In some of the de luxe models the insulated cooker can also be regulated by the time control. A time control is an added convenience



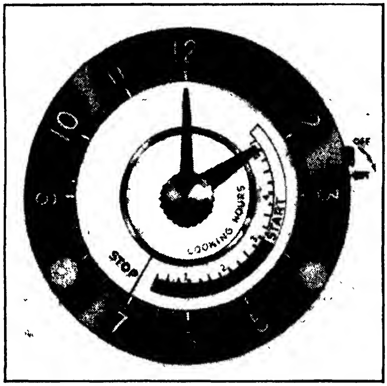
Pressed Steel Car Co.

FIG. 70. A functionally designed storage compartment.

in any home, but for the woman working out of the home it may cease to be a luxury and become a necessity. With a time control, food may be prepared several hours ahead of time, placed in the oven, the time and temperature controls set, and no further attention given until the hour for serving the meal.

In addition to the time clock, a clock that will remind the homemaker when the cooking operation is completed is a decided convenience. This clock may be either of the mechanical or electrical type and is usually known as a minute reminder. The dial of the clock is equipped with a pointer that is set to the minutes required,

and a signal rings when the cooking is completed. On some ranges the time clock and minute reminder are combined in one.



Frigidaire

FIG. 71. Dial of range timer.

THE INSTALLATION OF AN ELECTRIC RANGE

The cost of installing an electric range depends largely upon wiring conditions. The National Electric Code requires that where only one range is to be installed in a private residence the wires must be of sufficient size to carry the connected power load of the range. There are somewhat different regulations when the house contains two or more apartments in which electric ranges are used. When the range is to be installed in a residence where ample wiring in the entrance feeders is already provided, the installation cost of the range is comparatively low, as only service wires from the meter to the range must be added; but, if the range is installed in a house in which the entrance feeders are for the lighting load only, a new service circuit must be installed from the secondary main to the meter, and this additional wiring considerably increases the cost.

The size of wires used in range installation depends upon the type of wiring and the capacity of the range. In wiring a service circuit from the meter, however, it is good practice to use wires of sufficient size to carry a large-sized domestic range, in case of future need. The prevailing practice in range wiring seems to be to use three No. 6 or No. 8 wires on a three-wire 115–230 volt circuit.

An electric range should always be used on a circuit in which the voltage is approximately the same as that for which the range is de-

signed. "Modern high speed heating elements should not be subjected to voltages above the maximum operated voltage rating."[1] In a range designed for 118–236 volts, the maximum operating voltage is 124–248 volts. Increased voltage increases the temperature of the heating element, and experiments have shown that, as the temperature of the element increases, its life is shortened. When the line voltage is below the designed voltage, the normal speed of heating is decreased, but there is no harmful effect on the life of the unit. The life may even be increased.

As a protection against electric shocks, electric ranges should be grounded. The usual practice is to ground the range frame on the neutral wire of the range circuit. The ground wire may have to carry a large current, and wire smaller than No. 10 copper wire should not be used.

The National Electric Code requires that each appliance rated for more than 1650 watts shall be provided with some means of "cutoff" from the electric circuit. In single-family dwellings this may be either a plug and receptacle or the service switch. The service switch is more economical, but the plug and receptacle eliminate the necessity of calling a mechanic every time the range is disconnected or moved. It also provides a quick, safe means of disconnecting the range in case of fire and in servicing.

The operation of the electric range

For economical operation of an electric range a number of factors must be considered, such as the material, size, and shape of the utensils used, the regulation of the heat, and the methods of cookery.

Selection of utensils

Enclosed electric surface units transfer heat largely by conduction whereas heat in the oven is transferred by radiation and convection currents. As a result, the size, shape, material, finish, and color of a utensil may affect heat-transfer losses and losses by radiation as well as the type of food product obtained.

For surface cooking, flat-bottomed, straight-sided pans with tightly fittings lids should be used. These should fit the unit or be slightly larger. The flat bottom entirely covering the heating surface minimizes heat-transfer losses, and the straight sides offer less surface for radiation losses.

[1] *Electric Range Design Requirements,* Edison Electric Institute, New York.

Rounded-bottom utensils and utensils that are larger than the unit and have a recessed bottom or a bead around the outer edge should never be used. Battered and rounded-bottom pans result in a waste of electrical energy. Pans larger than the unit may cause the porcelain around the unit to become overheated and result in crazing or chipping. Since surface units transmit heat largely by conduction, utensils should be of materials that are good conductors of heat and should have flat bottoms that make good contact with the unit and straight sides that have low emissivity.

Glass and enameled ware absorb radiation more readily than do the shiny metals, but the metals emit fewer radiant rays. Black-bottomed pans absorb more radiant heat than pans with brightly polished bottoms. Tests with different kinds of materials and different colors, on all kinds of surface units, seem to indicate that the most economical pan to use on the electric range is one having polished reflecting sides and a dull-finished bottom.

If water is the medium for heat transfer, use small quantities. The temperature of live steam is the same as that of boiling water; hence the rate of cooking is the same in both mediums. Usually ½ to 1 cup of water is sufficient for cooking most foods if a tight lid is used. The size of the unit and the pan used should be determined by the quantity of food cooked. The lid of the pan should fit tightly to retain the steam. This rule does not apply, however, to foods in which the color is affected by steaming or by cooking in a tightly covered pan.

When containers such as casseroles and deep pans are to be used in the oven for steaming vegetables and fruits or for baking where a thick heavy crust is desired, the material of these utensils should have high absorption power.

When a material having a dark color or high absorption power is used in baking sheets, muffin pans, pie pans, and cake pans, it absorbs heat too readily and the food may burn on the bottom before baking is complete (p. 32).

For long, slow baking processes, or where a thin crust is desired, utensils should be made of materials which do not have high absorption power.

Baking sheets should be slightly smaller than the rack and should be placed in the center of the rack to allow for circulation of heat around the edges.

Tender meats should be cooked in an open shallow pan and can be started in a cold or preheated oven. Tests seem to indicate that meats

cooked in an uncovered shallow pan and started in a cold oven are as juicy and well flavored as meats seared and cooked in a preheated oven.

Arrangement of pans

Whenever possible the oven should be used to its fullest capacity. Baking pans should be so arranged that they do not touch the sides of the oven or each other. This arrangement allows for circulation of air around each pan and prevents uneven baffling of the heat. Layer-cake pans are staggered on top and bottom racks. (Fig. 92.) When covered dishes are used in the oven, the cooking is done by steam and the circulation of air is not so important.

Broiling

In the majority of electric ranges the broiler unit is the top unit of the oven. Broiling is cooking with radiant heat; the electric unit is, therefore, especially adapted to this type of cookery. The broiling unit is usually turned on "high" a few minutes before the food is placed in the oven to allow the heating coils to reach the maximum temperature. In high-speed broilers preheating is unnecessary. The power of the broiler is sufficiently high for the food to be placed under the broiler as the unit is turned on, and cooking starts immediately. The broiler pan is usually set about 3 to 4 inches below the coils. During the broiling process the door is left ajar.

Although the above suggestions for successful and economical operation apply to all electric ranges, each range has its own individual characteristics, and it is advisable for the homemaker inexperienced in electric-range cookery to follow the directions given for her particular range.

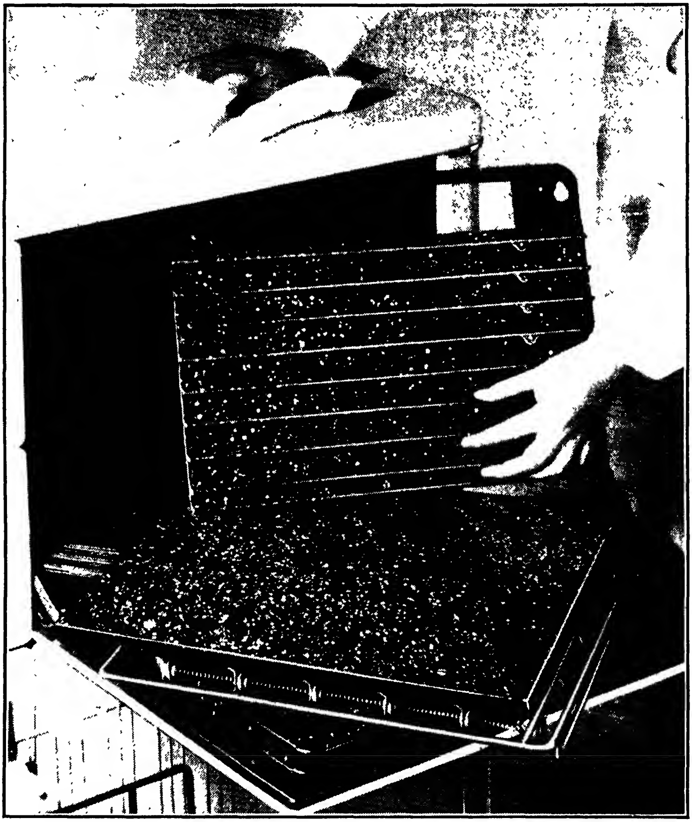
Cost of operating an electric range

The cost of operating an electric range depends upon the local rates, the techniques used in operation, the quantity of cooking done, and the methods of cooking used. Surveys indicate that the average amount of current used for a family of four is approximately 100 kilowatthours per month.

The care of the electric range

Electric ranges finished in synthetic enamel or porcelain enamel require an occasional washing with warm soapy water. It is not

advisable to wash the porcelain enamel on a hot range. The unequal expansion of the enamel and metal base tends to cause the enamel to crack or check. Chromium-plated parts require only washing, drying, and rubbing with a soft cloth.



Malleable Iron Range Co.

FIG. 72. Permanently attached heat distributor and removable shelf supports.

When an acid, as vinegar or lemon juice, is accidentally spilled on the enamel surface, wipe it off immediately, with a damp cloth. Although progress has been made in producing acid-resistant porcelain enamels, acids allowed to remain on enamel may stain it or remove the gloss.

Foods spilled on closed units may be wiped off or, if necessary, removed with any mild abrasive; food spilled on an open unit must be burned off and is best removed by charring during a regular cook-

ing process. A stiff brush or sharp instrument should never be used because of the danger of injury to the heating coils.

The oven shelf supports and heat distributor, if they are of the removable type, and shelves may be taken out and washed with soap and water. (Fig. 72.) Spilled food should be removed as soon as the oven has cooled, using a mild abrasive if necessary. It is good practice always to wipe out the oven with a damp cloth after baking or roasting, since, with successive use, greasy deposits are burned onto the lining and are removed with difficulty.

Electricity as a source of heat

Electricity is a clean and a safe source of heat. Heat is produced by the resistance of a wire to the passage of an electric current; hence there is no flame. The current is under control, is easily regulated, is not subject to atmospheric conditions or drafts, and will not be extinguished by the boiling over of liquids. Heat is largely confined to a small area so that the homemaker has comparatively cool working conditions. Since electric heat is not a product of combustion, gases cannot be formed as by-products.

Summary

1. An electric range should be finished with easily cleaned material and should be simple in design and durable in construction.
2. Ranges are manufactured in a sufficient number of types and sizes to meet individual requirements.
3. Enclosed surface units are available in several different types of construction. The tubular type is the most efficient. These units are known as "high-speed units" because of their low thermal mass.
4. The heating element of surface units is made up of one or two coils, which are used singly or connected, to give the various heats.
5. Insulated cookers are standard equipment on most ranges.
6. Ovens should be well insulated to retain the heat. Oven linings, preferably in one piece, should be of a material that is non-rusting and should have a finish that maintains an attractive and efficient surface with use. Most ovens are equipped with two units. A metal heat distributor over the bottom unit redistributes the radiant heat and directs the convection currents uniformly throughout the oven.
7. The heating of the oven is regulated by a thermostat. The current is turned on or off by a switch operated by the expansion and contraction of a material placed in the oven, usually a tube of mercury.
8. Surface and oven units are usually controlled by rotary switches.

9. Time clocks and minute reminders are usually standard equipment on de luxe models and can be purchased with other models at extra cost.
10. Many models have special features such as utility drawers, warming drawers, oven lights, platform lights, master and individual pilot lights, and condiment sets.
11. In installing a range, use wires of sufficient size, and connect to a circuit of approximately the rated voltage. Provide an easy means of disconnecting the range from the circuit in case of need.
12. The careful selection of the right kinds of utensils and efficient methods of cookery will make for economical operation of the range.
13. Enameled ranges may be washed when cold. Wiping a hot range may cause the enamel to check or crack. Enclosed units may be washed off and scoured with a mild abrasive. Spilled food on open units should be burned off and removed with a soft brush.

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6

Gas

GAS WAS FIRST USED almost exclusively for lighting, but since about 1915 there has been a gradual change until at present 90 per cent or more of the gas load is utilized for heating purposes.

The gas appliance most frequently used in the home is the gas range. Gas is also extensively used for house heating, space heating, water heating, and refrigeration. The gas range is discussed in the following chapter. Gas refrigerators are discussed in the chapter on refrigeration; and water heaters, in the chapter on laundry procedure.

In general, four kinds of gas are available in the United States: manufactured gas largely on the Eastern Seaboard, natural gas and mixed manufactured and natural gases in the rest of the country, and liquefied petroleum gases where there are no mains. All these gases are piped into the house and require no home storage facilities, with the exception of some types of liquefied petroleum gas that are supplied in cylinders, placed in a cabinet or buried in the ground outside the house. At present many of the cylinder installations may be arranged for metering the gas within the home.

None of these gases requires the attention of the user, the supply company maintaining adequate service. Gas is a clean fuel. Manufactured gas has a characteristic odor. Natural gas, although practically odorless as found, is often artificially odorized for detection of leaks.

The price of gas must be determined by local rate schedules.

History of gas

Many centuries before manufactured gas was produced, natural gas was known, although usually its true nature was not recognized. The oracle at Delphi in ancient Greece is believed to have been natural gas issuing from a crevice in the earth. The Chinese, who reached a high degree of culture and development while Europe was still largely inhabited by half-civilized tribes, found natural gas in scattered regions of their country and, piping it through bamboo tubes,

utilized it for light. In 1667 Thomas Shirley reported to the Royal Philosophical Society of London the discovery of a spring through which bubbled a gas that could be ignited.

But before this time, in 1609, Van Helmont of Brussels had found that burning fuels gave off an invisible substance, "a wild spirit," which he named gas. Van Helmont used wood to make the gas, but fifty years later Dr. John Clayton, a Yorkshire minister, heated coal in closed vessels and also obtained a combustible gas. He liked to amuse his acquaintances by collecting the gas in bladders, pricking the bladders, and lighting the gas as it escaped through the holes.

More than a hundred years after Clayton, in 1792, William Murdock, generally regarded as the father of the gas industry, produced gas by the distillation of coal in an iron retort and used it to light his home. Murdock was a construction engineer in the employ of James Watt, of steam-engine fame, and after his experiments had proved sufficiently successful he lighted the Soho foundry where the steam engines were built. Later he established gas works to light a cotton mill in Manchester.

Meanwhile similar experiments were being carried on in other countries. Investigators in both Belgium and France had succeeded in distilling gas from coal, and in 1812 David Melville of Newport, Rhode Island, manufactured gas and lighted his home and the street in front of the house. But it was a German, Frederick Winsor, who first advocated and attempted the use of gas on a large scale. He went to England and there obtained the first patent for making gas. Winsor pointed out the advantages of gas for heating as well as for lighting and showed what valuable by-products might be saved in this way. He finally convinced the authorities of the feasibility of gas for street lighting, and in January 1807 his company lighted Pall Mall in London. The company obtained a charter in 1812—the first gas company in existence—and in spite of prejudice and opposition the lighting of London streets spread rapidly. Baltimore was the first American city to have a gas-lighting company. This was in 1816.

Other cities soon followed these examples. Later, gas was used in public buildings and in the private homes of some of the wealthier citizens; only very gradually did it find extensive use in the average home. Today, as has been noted, it is most widely employed for heating purposes, not only in the home but also in industry. It has been estimated that industry alone has found more than 25,000 different uses for gas.

Physics of gas

Gas is composed of molecules continually in motion. Since a gas tends to expand and diffuse, the molecules completely fill the containing vessel, and their motion is limited only by the size of the inclosed space. They exert equal pressure in all directions. The tendency of a gas to diffuse is the fundamental essential for gas flow. Just as water flows from a higher to a lower level and heat flows from a hotter to a cooler body, so gas flows from a place of higher pressure to one of lower pressure.

Heating value

When gas was used principally for lighting, the consumer was interested in its candle power. Today, with gas so largely a source of heat, he wishes to know the heating value. This value is expressed in British thermal units (Btu). A therm is equivalent to 100,000 Btu.

Coal gas and carbureted water gas

During the earlier years the gas industry relied almost entirely upon coal gas prepared from bituminous coal heated in closed vessels known as retorts. Coal-gas manufacture continued as the standard process in this country until 1873, when Thaddeus S. C. Lowe developed practical methods for utilizing the action of steam on incandescent carbon, the fundamental basis of carbureted-water-gas production. The chief constituents of coal gas are hydrogen and hydrocarbons. Carbureted water gas consists of a mixture of carbon monoxide and hydrogen that has been enriched with gases produced from the heating and chemical decomposition of a spray of oil.

The type of process used in the manufacture of gas, together with the manner of its distribution, necessitates employment of a storage holder. From the holder, gas is distributed in a system of underground mains in which the pressure is automatically controlled at all times. The mains are commonly of cast iron or steel. Gas passes from the mains to small lateral pipes that run into the individual homes.

Natural gas

Natural gas, available in forty of the forty-eight states, is found underground, filling the interstices of porous rocks, known as "sands." The deepest drilled sands today are more than two miles below the surface. Above the sands is a thick stratum of impervious rock that

has prevented the gas from working its way to the surface of the earth and escaping. Just how nature made this gas is unknown, but by some means or other large volumes of the gas have been forced into cavities between the grains of sand and are held there at various pressures known as "rock pressure." This pressure causes the gas to flow mechanically from well to consumer, but it decreases as gas is withdrawn through a well, since the remaining gas expands and fills the crevices.

When the well has been drilled down into the cap rock above the gas sand, a casing is set in the hole to prevent water from seeping in at the sides. Through the center of the casing, drilling continues, and other casings may be set before the desired depth is reached. Finally a pipe is dropped inside the casing and fastened in such a way that the gas must come up through this "tubing" and not escape around the sides.

Gas expands as it comes out of a well and may need to be recompressed to have sufficient pressure to overcome friction of the pipe. Any natural gasoline or oil vapors mixed with the gas are also removed, and the gas is cooled. If gas has to be transmitted a long distance, additional compressing stations are installed along the line.

Liquefied petroleum gases

Central systems. In a number of towns in the United States the gas supply is furnished by gas made from liquefied petroleum products consisting of propane and butane. Usually the gases are distributed as butane-air mixtures from a central mixing plant through an all-welded steel distribution system. The mixture often contains about 550 Btu per cubic foot, giving a gas similar to manufactured gas in its heating value, although similar to natural gas in its flame characteristics. Butane-air and propane-air mixtures having higher heating values are also used.

Certain companies located in warm territories, such as California, distribute an undiluted vapor of high heat value, between 2500 and 3200 Btu per cubic foot. The undiluted gases burn with characteristics similar to the bottled gases described later; in fact, they are identical with the bottled gases except that they are vaporized in a central system rather than from individual house installations.

Bottled gas. Bottled gas, also called portable and cylinder gas, is in use in almost 400,000 homes and forms a very satisfactory source of supply for homes not able to secure gas from a utility. The fuel in

the tanks is propane or butane, or a mixture of the two, and is derived from oil refinery and wet natural-gas sources or from the fractional distillation of natural gasolines. It is liquefied and shipped to distributing centers in special tank cars. From the distribution points it is delivered to the home in cylinders containing 47 to 95 pounds of the liquid. The cylinders are placed in a cabinet outside the home, or are buried in the ground, and are connected, through a pressure-regulating valve, to the house gas-pipe system. Some distributors fill the cylinders at the customer's premises from a tank truck; others replace used cylinders with fresh ones from the central supply.

Propane changes to a gas under all temperature conditions likely to be encountered in the United States, and consequently a uniform gas at a uniform pressure is obtained as long as any liquid remains in the cylinder. A 95-pound cylinder contains approximately 2,057,000 Btu. Butane often requires some outside source of heat to assist in vaporization.

Chemical composition of gases

The exact chemical composition of various commercial gases is relatively constant in any one locality but varies from town to town,

TABLE 1 *

PROPERTIES OF TYPICAL COMMERCIAL GASES

Gas	Constituents of Gas—Percentage by volume								Specific gravity	Btu per cu. ft. gross
	Carbon dioxide	Oxygen	Nitrogen	Carbon monoxide	Hydrogen	Methane	Ethane	Illuminants	(air = 1.0)	
Natural gas (Birmingham)	...	..	5.0	...	..	90.0	5.0	...	0.60	1002
Natural gas (Los Angeles)	6.5	...	.....	.....	.....	77.5	16.0	...	0.70	1073
Coke oven gas	2.2	0.8	8.1	6.3	46.5	32.1	...	4.0	0.44	574
Coal gas (horizontal retorts)	2.4	0.75	11.35	7.35	47.95	27.15	...	3.05	0.47	542
Carbureted water	4.3	0.7	6.5	32.0	34.0	15.5	...	7.0	0.67	534
Commercial butane	(Butane 93.0, propane 7.0)								1.95	3225
Commercial propane	(Propane 93.0, other hydrocarbons 7.0)								1.52	2572

* Table condensed from *Combustion*, published by the American Gas Association.

depending on the source of the raw materials from which the gas is made or of the wells from which natural gas is drawn. Consequently the compositions that are given here represent typical cases, and it should be borne in mind that any one gas may be quite different. (Table 1.)

Other commercial gases are made today by various combinations of the gases described in the table, and by re-forming of natural gas through a process analogous to the water-gas process. Communities will also be found in which gases are derived from oil. From time to time in various parts of the world gases have been produced from almost any material that will burn: coffee has been used in Brazil; cornstalks have been tried experimentally. All these interesting facts illustrate how adaptable gas and gas making really are.

Specific gravity

From the table it will be noted that the specific gravity of all the fuel gases except the liquefied petroleum group is lighter than air. Air weighs 0.0765 pound per cubic foot at 60° F.; the fuel gases weigh 0.029 pound per cubic foot for coke-oven gas up to about 0.054 pound per cubic foot for natural gas. Liquefied petroleum gases are anywhere from $1\frac{1}{2}$ to 2 times as heavy as air.

Heating value

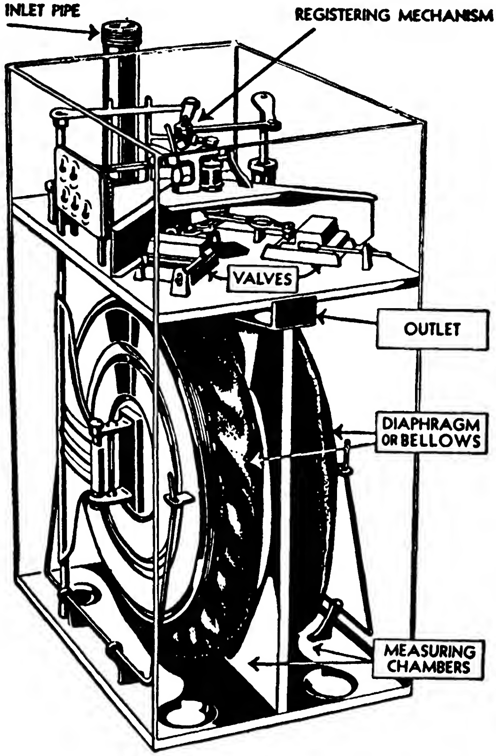
The heating value of typical gases has also been given in the table but will vary in individual towns from 450 to 650 Btu per cubic foot for straight manufactured gas, with the majority of plants operating at 500 to 550 Btu per cubic foot. In many states heating value of manufactured gas is subject to strict regulation, and companies are permitted only a very small variation from the prescribed standards.

Differences in natural gas are also encountered, and the typical value of 1000 or 1050 Btu per cubic foot may be exceeded by as much as 500 Btu when high percentages of ethane are present. The Btu values of the liquefied petroleum gases have already been given.

The meter

Gas piped into the home from a distributing center is measured by a meter. The meter has a top partition in which two slide valves admit the gas to the lower chambers. The lower part has a partition through the center, and each half contains a flexible leather diaphragm, oil-treated to keep it pliable. (Fig. 73.)

Gas enters the top chamber from the inlet pipe and is directed through the valves into the lower chambers, which fill and empty alternately, allowing the gas to come from the meter in a steady steam. The meter operates only when a customer, by turning an appliance valve handle, causes the gas to flow.



American Gas Assoc.

Fig. 73. Inside the gas meter.

A crank connected to the valves is geared to dials that record in cubic feet the amount of gas passing through. The dials are interconnected, and one complete revolution on a given dial is indicated on the dial of next higher value by the distance between two units; e.g., when the hand on the 1000 dial has made one complete revolution, the hand on the 10,000 dial will have moved from 0 to 1. Owing to the interlocking of the gears, every alternate dial records in the reverse direction. Always read the last number which the pointer has passed. Set down the figures reading from left to right, and add two ciphers. The dials in Fig. 74 indicate a reading of 490,600 cubic feet.

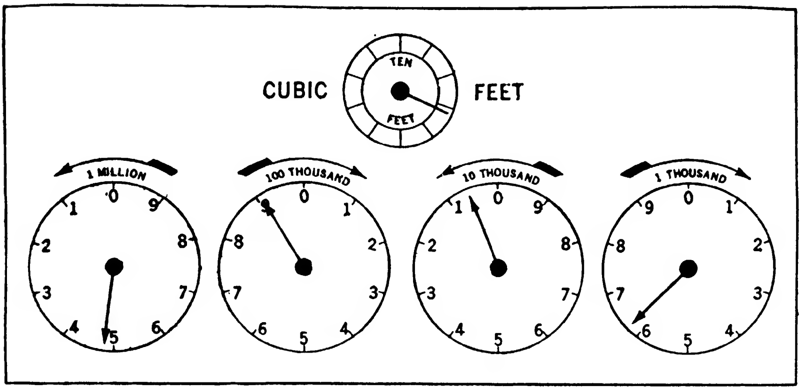


FIG. 74. Dials on a gas meter

It is not customary to turn the dials back to zero each month, but the meter reading of the previous month is subtracted from the reading of the current month. This procedure counteracts any error that may occur in a reading.

SUMMARY

1. Gas is obtainable in four forms: manufactured, natural, a combination of natural and manufactured, and liquefied petroleum gas.
2. Manufactured gas is made in all the states; natural gas is now piped into forty of the forty-eight states; liquefied petroleum gas is distributed in all states.
3. Gas flow from source to appliance depends upon the tendency of a gas to diffuse from a place of higher pressure to one of lower pressure.
4. Gas is rated in Btu heating value.
5. Manufactured gas has an average heating value of 550 Btu per cubic foot; natural gas, 1050 Btu; and liquefied petroleum gas from 2500 to 3200.
6. Gas is measured by a meter which operates whenever gas is being consumed.

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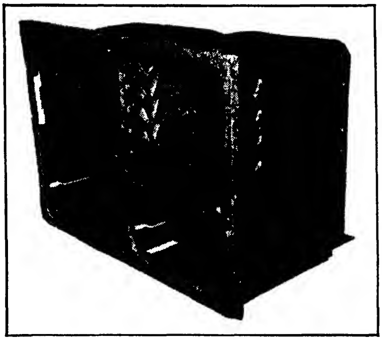
7

The Gas Range

THE GAS RANGE is the gas appliance most commonly found in the home. According to government statistics almost half of the families in the United States, approximately 48 per cent, cook with gas. A survey of 64 cities gave an even higher percentage, almost 70.

CONSTRUCTION

Gas ranges are made from cast iron or steel. In the cast-iron range the frame, legs, and top are cast, but the panels are usually of sheet iron. If properly machined, the somewhat heavy construction holds its shape and is a most satisfactory base for the porcelain enameled surface—the most desirable finish for a range. The strength and elasticity of steel permit the manufacture of ranges light in weight with welded unions, offering great resistance to repeated shock. (Fig. 75.) The steel must be very low in carbon content, preferably less than 0.2 per cent, to take enamel well. Legs may be adjustable, an aid in installing the range so that cooking top and oven racks are level. Many ranges now have a recessed base, similar to the kitchen cabinet base, giving a uniform appearance to the installation. A base integral with the range is recommended for the sake of solidity.



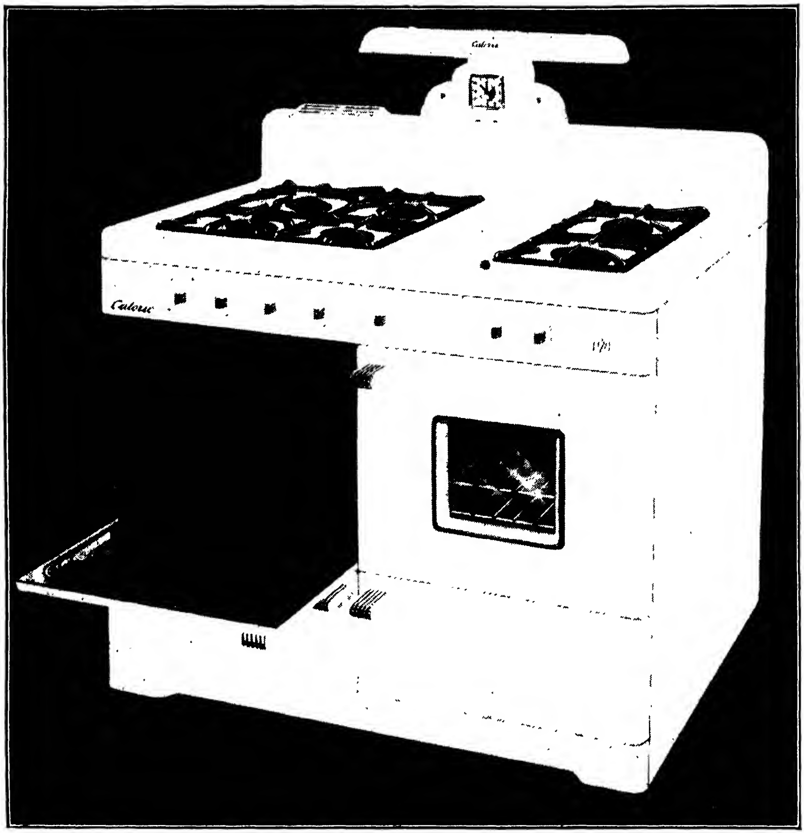
American Stove Co.

FIG. 75. The range frame with its reinforced construction is engineered to last for years of hard usage.

New ranges have improved construction features in the better fairing of surfaces into each other and the stamping of main top and back guard in one piece without joints. (Fig. 76.) They are usually made with flush-to-wall back panels, and some models have a cutout on the side panels to fit over the baseboard; this allows for even closer installation. The all-white range is preferred; even the burner trays and bowls are now frequently finished in white porcelain enamel.

TYPES OF RANGES

The table-top range with the cabinet base is the model most commonly manufactured although one model with the raised oven has again been placed on the market. (Fig. 77.) It offers more con-

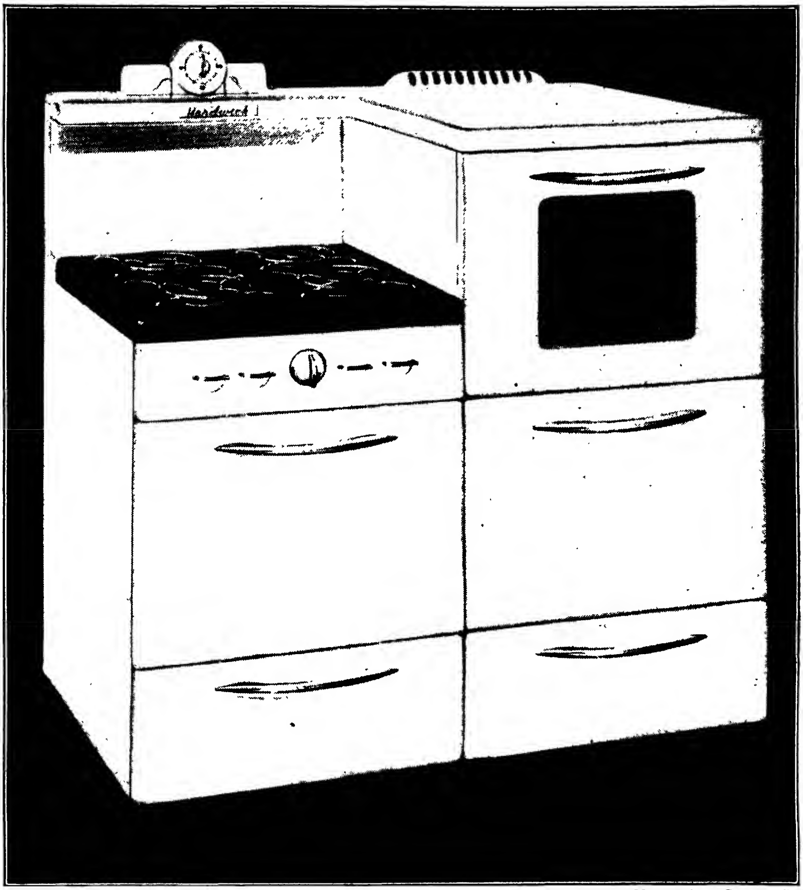


Caloric Stove Corp.

FIG. 76. A modern gas range.

venience in oven and broiler use but affords less easy access to top burners next to the oven wall. It also destroys the continuity of work surfaces, all at the same height, so favored in the modern kitchen. The table top provides a work area beside the surface burners and storage space in cabinets or drawers. A second type, especially adapted for small kitchens where space is limited, has three or four surface burners with oven and broiler directly below them. (Fig. 78.) This range has no work area. The "bungalow range" has a similar ar-

rangement of surface burners, oven, and broiler and in addition has a supplementary fuel section at the side, used primarily for space heating. (Fig. 98.) Combination ranges, which somewhat resemble



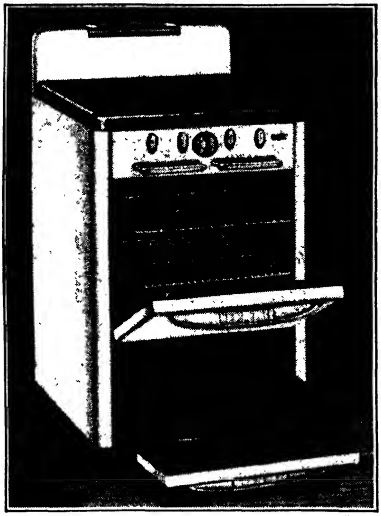
Hardwick Stove Co.

FIG. 77. New range with elevated oven.

the bungalow range, will be discussed in the section on coal ranges, Chapter 8. Ranges vary in width from 19 inches to approximately 60 inches, depending on the manufacturer. Some of the widths specified are 19, 20, and 21⅝ inches for the smaller, apartment ranges and 36, 36¾, 40¾, and 58½ inches for the larger sizes. Depth of range varies from 22 inches to 28½ inches.

The cooking top itself may be one of three types: open, in which a grate, single or divided, is over the entire burner surface; semi-enclosed, with each burner surrounded by a porcelain enameled bowl, covered by a separate grate; solid top, similar to the top of the coal range, with lids.

There should be a removable burner tray beneath all top burners to catch whatever falls through the grates. It should have a raised edge, tight corners, and an easily cleanable, rust-resisting finish. On open-top ranges it is customary to raise the burner tray above the mixing tubes so that the burners are encircled. It is then called an aeration pan or plate and serves the double purpose of directing the currents of secondary air to the flame and of collecting spill-overs. The bowl acts in a similar manner. Sometimes, instead of being separate, the bowls are a part of the permanent construction of the aeration pan. The shape of the bowl also directs the secondary air and at the same time restricts the heat to a limited area instead of allowing it to dissipate at the sides. The difference between the two constructions is apparent from Figs. 76 and 77. Both arrangements limit the amount of cold air drawn in around the utensil. An excess of secondary air decreases flame temperature and causes unnecessary heat loss. Aeration plates and burner bowls are usually not completely effective in catching all the boil-overs, and it would greatly assist in cleaning the range if a burner tray were always supplied.



Geo. D. Roper Corp.

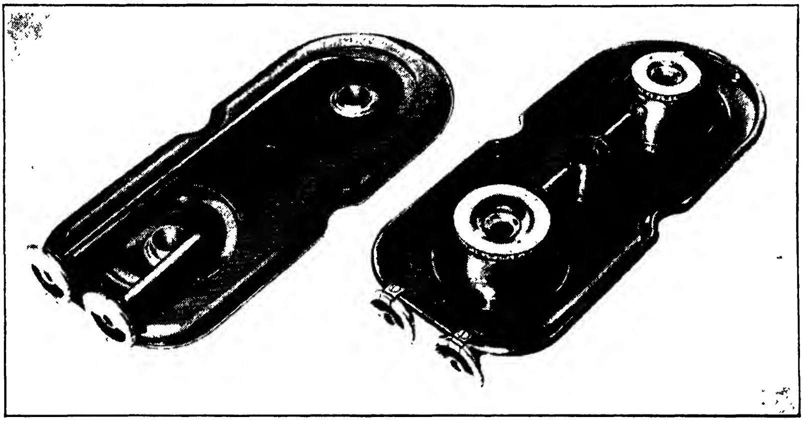
FIG. 78. A range for limited space. It contains most of the features of the larger range.

A new model has the burner, tray, and lighting equipment welded together into one unit. (Fig. 79.) A range having this construction is exceptionally easy to clean, as there is only one part to remove. The tray will hold almost a quart, in case of a boil-over. The orifice and burner head cannot get out of alignment and neither can the pilot light and lighter tubes. The burner is draft resistant, which is important on the simmer setting.

ARRANGEMENT OF BURNERS

The modern gas range offers a variety of burner arrangements. Four burners are commonly supplied, although ranges with six or eight may be purchased.

When there are four burners they may be grouped at the right or left side of the top surface, leaving the remaining space free for a work area, or the four burners may be divided, with two on each side



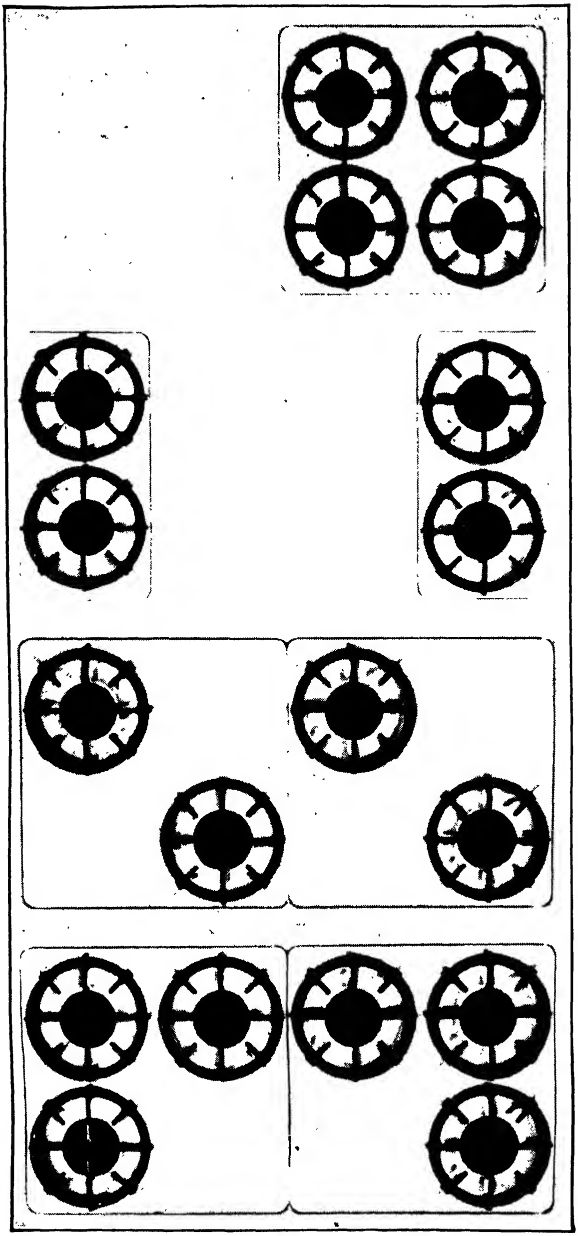
Magic Chef, American Stove Co.

FIG. 79. The new one-piece burner and tray, bottom and top views. The burner and lighter parts are built right into the sanitary tray. The burner is porcelain enameled inside and out for a cleaner, non-fluttering flame.

and work space in the center. These two arrangements have proved the most popular with homemakers. (Fig. 80.) Occasionally the four burners are in the center of the top with a narrow work surface at either side. (Fig. 98.) Another arrangement is to stagger the burners. Space beside each burner is then available, and pan handles do not interfere with each other.

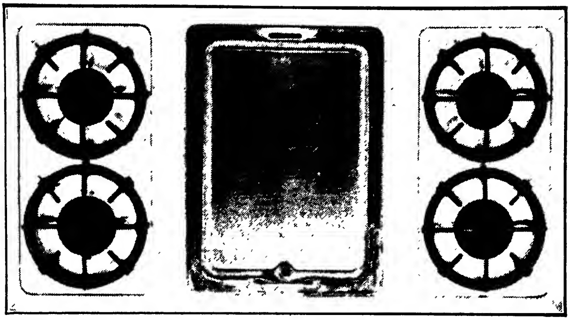
The four burners may form a line across the back of the top with the free area in front of them. When an additional burner is installed at either end, the range has six burners. Another six-burner arrangement groups four burners at one side and two at the other, with a narrow free area between. (Fig. 76.)

In an eight-burner range, the entire top is occupied by burners, leaving no free space. Four of the burners may be replaced by a built-in griddle, with or without a broiler space beneath. The griddle may be at one side or in the center of the range top. (Fig. 81.)



Geo. D. Roper Corp.

FIG. 80. A variety of arrangements of surface burners.

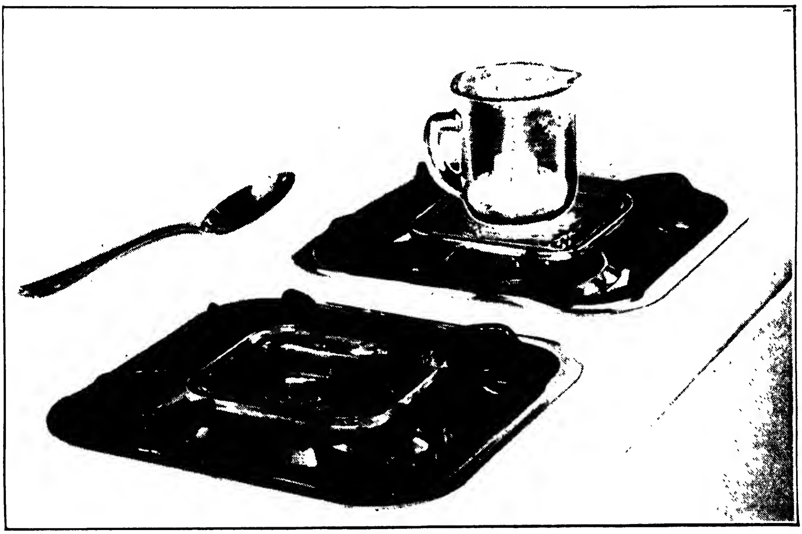


Geo. D. Roper Corp.

Fig. 81. Griddle built into top surface of range.

GRATES

American Standard Approval Requirements for gas ranges state that grate arms shall support a utensil of $3\frac{1}{2}$-inch diameter, placed centrally over a burner. At least a $\frac{5}{32}$-inch vertical clearance shall be



Tappan Stove Co.

Fig. 82. Burner with glass inset in grate.

provided between the top surface of the grate bars and the cooking top of the grate or of the range itself. The grate should be sturdy, but light in weight to absorb as little heat as possible. Minimum contact with the range top prevents heat transfer away from the cooking vessel and increases efficiency. A good deal of variety in design is

apparent in the grates on new ranges, especially in those over burner bowls.

Some manufacturers place a square or disk of heat-resistant glass over the center of some of the surface burners. It protects the burners from spill-overs and is a very adequate support for small utensils that sometimes tip on grate bars. These glass plates are made highly resistant to any shock from extreme heat or sudden cooling. (Fig. 82.)

Burner parts

Approximately 75 per cent of range cookery makes use of surface burners. Although they differ somewhat in form, the principal parts are the same, with mixer head, mixing tube, and burner head cast in one piece to prevent gas leakage. The mixer head carries an air shutter, and an opening for the gas orifice. (Fig. 83.) The orifice is the opening in the spud or cap through which the gas flows and by means of which the flow is controlled. Orifices may be fixed or adjustable. They are always fixed when liquefied petroleum (LP) gases are used. The orifice cap is movable and regulates the flow of gas by change of position with respect to a stationary needle or other device. The orifice spud, in contrast, has a fixed opening; when a different-size opening is desired, the spud is usually exchanged for a new one.

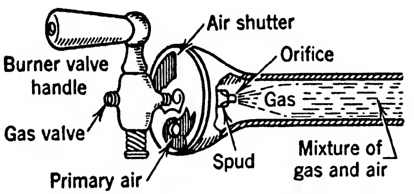


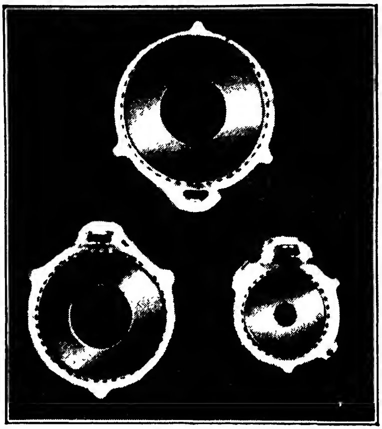
Fig. 83. Gas and primary air mix in the tube.

The openings in the burner, known as ports, may be drilled vertically, horizontally, or at an angle of 45°. With vertical ports, the flame is directed upward and covers a definite area of the utensil bottom, limited by the size of the burner. Round burner heads usually have ports at a 45° angle. The ports are drilled or may be an integral part of the removable central section of certain "die-cast" burners. There are usually two sets of such ports, the larger number on the outer circle and a small number, five or six, on the inside curve, to heat the central portion of the utensil bottom. The round burner varies in diameter from 2½ inches to 3½ inches, and this comparatively small size, together with the angle of the ports, greatly reduces the possibility of clogging when boil-overs occur. A central air shaft in this type of burner supplies additional secondary air.

Horizontal ports may be in the form of a slit that produces a continuous ribbon flame around the burner head.

SIZE OF BURNERS

Ranges may have burners of three sizes: giant for rapid heating and for large utensils, regular for general cooking in average-size utensils, and simmer for low heat. The simmer burner is usually a part of a larger burner; when the valve is partly closed, the gas is shut off from the main burner and the simmer alone supplies heat. When no simmer position is provided, the gas may be reduced at all the ports to the amount of heat required.



Universal, Cribben & Sexton

FIG. 84. In addition to the giant and regular burners, a separate small burner is featured on some ranges.

The most efficient method of operation is to have the gas turned on full. The simmer is, therefore, to be preferred to a larger burner turned down—the simmer is burning at full speed and only the size is reduced. This small flame prevents excessive escape of heat into the kitchen, is an asset in waterless cookery, and may be reduced in size to keep foods warm. A few ranges also feature a separate small burner. (Fig. 84.)

HEAT CAPACITY OF BURNERS

The giant burner is built to have a heat capacity of not less than 12,000 Btu per hour, the regular burner not less than 9000, and the simmer burner not less than 1800. This is equivalent to approximately 22, 16, and 4 cubic feet of manufactured gas per hour, respectively. Since natural gas has a higher Btu content, the burners consume less gas to give the same amount of heat: the giant an average of about 11 cubic feet per hour, the regular burner an average of 8.3 cubic feet.

PATH OF GAS FLOW

The horizontal pipe through which gas flows to the different orifices is called the manifold. On present-day ranges it is usually concealed behind the front panel of the cooking top but may be behind the back guard. Attached to the manifold are burner valve handles, operated by hand, which direct the gas through orifice and mixing

head into the burner. Forced through the orifice with a velocity of 100 to 160 feet per second, the gas develops sufficient suction to draw air from the room through the partly open shutter. This air, known as primary air (Fig. 83.), mixes with gas in the tube, but the mixture will not burn without the presence of secondary air that surrounds the burner and supplies the additional oxygen required. With natural and portable gas of higher Btu content, the orifice is smaller, the flame shorter, and the burners nearer the grate.

The new gas range, with the tray, burner, and lighting equipment in one, has placed the burner as close to the grate for all types of gas as is customary for only LP gas. The only adaptation necessary for the different gases is obtained by changing the orifice cap and adjusting the air shutter. The cap is made of steel plated with chromium. The unit is finished in porcelain enamel inside and out to make it rustproof. The gas-and-primary-air mixture passes through a porcelain-lined venturi tube. This smooth finish increases the injection of primary air and gives a clean, sharp flame. The rough interior surface of the usual cast-iron burner tends to cause gas turbulence. The flame on this new range is not affected by heat from the oven or broiler.

Lighting the burner

Most ranges are now equipped with automatic lighters for the surface burners. A tiny gas flame burns continuously in the center

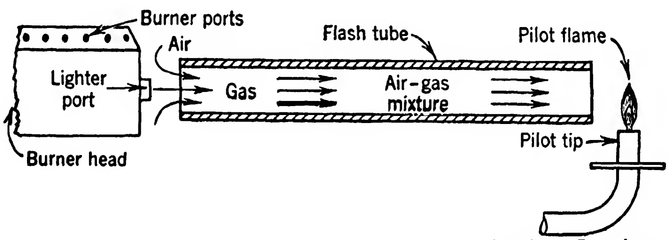


Fig. 85. Top burner automatic lighter.

of the top cooking surface and from it flash tubes run to each burner. (Fig. 85.) When a burner valve handle is turned, the air-gas mixture from the burner flows into the tube and ignites at the central flame, but, since the tube contains too large a proportion of air for normal combustion, the flame flashes back to the burner and ignites it also. When the automatic device is functioning correctly, the burner lights within 4 seconds.

In the new range, to which reference has been made, the lighter tubes are above the drip pan and are not affected by spill-overs. A multiport lighter port is constructed flush with the burner casting. (Fig. 79.)

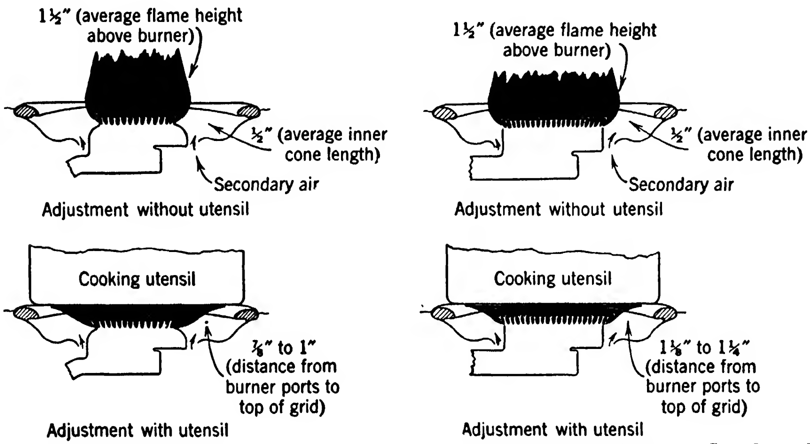
If necessary to use a match for igniting a burner, turn the gas on full, wait a second, and apply the lighted match a short distance above the burner ports. Gas should ignite completely and without delay. The "off" position of the gas valve, controlled by the burner valve handle, must be clearly and unmistakably indicated. High heat and simmer positions should likewise be marked. Some new burners also have a medium heat position that is indicated on the manifold panel, and at least one manufacturer provides for a second stop for the simmer burner, where the flame is so small that only enough heat is produced to keep the food warm.

Flame adjustment

In determining the correct adjustment of a flame, a distinction must be made between one rising from vertical ports and one from ports at a 45° angle. The vertical ports are not commonly found on the new ranges and will not be considered here.

The 45° angle and ribbon flames project outward for an inch or two; they are then lifted upward against the utensil bottom by the inrush of secondary air around the burner and the natural expansion of the gaseous products of combustion. The flames extend 1 to 2 inches above the grates and should have a 6-inch spread under the utensil on a regular burner and a 7¼-inch spread on a giant. (Fig. 86.) These flame types have a wide range of heat adjustments and may be turned fairly low without being extinguished. The simmer flame should not extend above the grate and should maintain water—in amounts up to 6 quarts—at boiling temperature when the vessel is covered. Correct adjustment of the burners is of primary importance since liberation of heat from the flame depends upon the primary air-gas ratio and may differ as much as 50 per cent in two flames of equal size. Satisfactory adjustment of the new type of burner is frequently difficult because of the inaccessibility of orifice and shutter and should be left to a qualified service man. In the burner that is integral with the aeration pan, air and gas adjustments may be made without removing burner and pan. In fact, the gas flame may burn during the adjusting operation. In some other burners the air may be adjusted with the burner in place.

If the burner is at so great a distance from the utensil that a long flame is needed, or if an excessive draft tends to blow the flame, a large portion of the heat passes off at the side and gas is used inefficiently. For minimum operating cost, the flame should be as close to the bottom of the vessel as possible without the formation of carbon monoxide gas. The usual distance between grate top and burner is 1⅛ inches, but some ranges have reduced this space to ¾ inch, and at least one to less than ½ inch. This shorter distance has proved



American Gas Journal

FIG. 86. *Left:* Correct adjustment for regular top burner. *Right:* Correct adjustment for giant top burner.

especially feasible on ranges using a fixed orifice with a governor to maintain constant pressure. Some utilities secure greater efficiency by installing an individual pressure regulator with each range.

COMBUSTION PROCESS

According to usually accepted theories, combustion of gas takes place in two steps. The first consists of the partial union of the oxygen in the primary air with the hydrocarbons in the gas to form carbon monoxide and hydrogen; the second, the complete combustion of these products to carbon dioxide and water vapor.

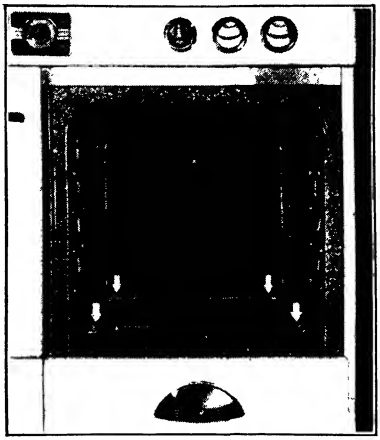
A closed-top range is carefully designed to obtain the requisite amount of secondary air by placing the burners at a greater distance from the top of the stove and by having the vents above the burners connected to the range flue. The products of combustion are easily and quickly removed through the flue and do not interfere with the

further burning of the gas. A closed top should never be placed on an open-top range. Secondary air will be partly shut off, and incomplete combustion and the escape of toxic gases will result.

Ovens

Depending on method of heating, ovens may be grouped into two types.

1. Semidirect, in which the burner is under a bottom or baffle plate but there are no flues directing circulation. The insulated ovens of the CP ranges are usually of this type.
2. Circulating, in which the gases and air currents are directed by a system of flues. The outlet may be near the top or the bottom of the rear wall.



American Stove Co.

Fig. 87. Semidirect oven of floating type. The oven bottom is attached to the range body in only four places. Flow of air from oven is restricted.

Whatever the method used, the products of combustion and the steam and other volatile by-products of the baking process pass out of the oven through a vent, usually located at the top of the rear panel with the outside opening on the back guard. (Fig. 98.) The opening is so placed that the flue vapors will be directed away from the wall. The vent grill is frequently chrome finished and may be removable for ease in cleaning. In some ranges the vent is so constructed that it restricts the too rapid flow of heated air from the oven. In this way the circulation of air in the oven is controlled and uniform heat distribution is obtained. (Fig. 87.) The homemaker should never attempt to regulate the flow of air from the vent by stuffing steel wool into the vent outlet.

The American Gas Association Testing Laboratories do not require that the vent be connected to a chimney, but such a connection, by carrying away odors, volatile grease from cookery processes, and excess moisture, together with the products of combustion, helps to keep the wall behind the range clean and the kitchen atmosphere cool. The flue behind the wall cabinets which are above the gas

range, in the new kitchen plans proposed by the American Gas Association, removes volatile food substances as they are produced and prevents their spread throughout the kitchen (p. 311).

Size of oven

Most ovens on the market are 16 inches wide and 14 inches high, with a somewhat varying depth; usually a desirable depth is about 19 inches if a large-sized roaster is to be accommodated. Larger ovens, 18 inches wide, are preferred by homemakers who do quantity baking. When ranges have two ovens, one is frequently large and the other only 10 or 12 inches high for small baking operations. The door should close tightly and be so counterbalanced that it will remain at any desired angle when opened.

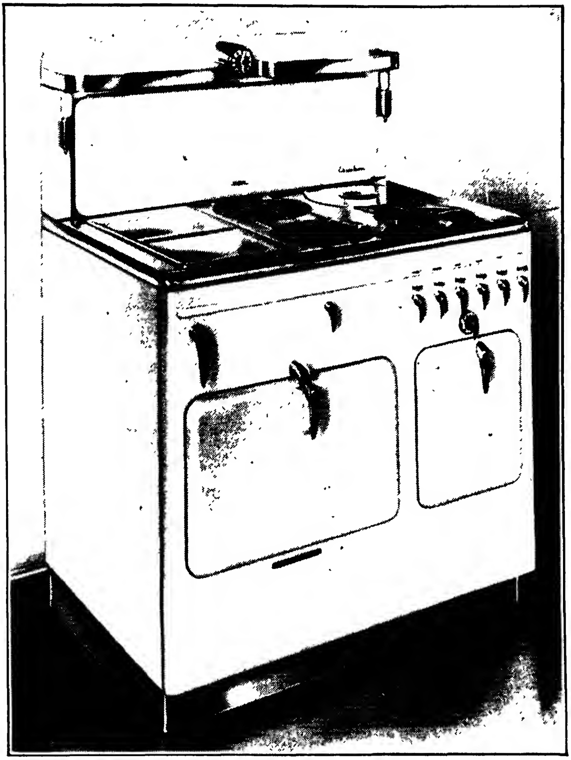
Oven racks should have a positive stop, that they may be pulled out without tipping. The rods or flat metal ribbons should be closely spaced for adequate support of small baking utensils. The materials used for rack construction should be rustproof and stain resistant.

Insulated ovens

The present tendency is to insulate the oven with a packing of mineral wool or Fiberglas, which should be at least 1¼ inches thick to prevent excessive heat leakage to the outside. Ovens constructed for cooking largely on retained heat are insulated more heavily and on all sides. (Fig. 88.)

One manufacturer provides double insulation for his range ovens. A third steel wall is built between the inner and outer oven walls, dividing the space into two parts. The section next to the oven is packed with rock wool; the outer section is a dead air space that helps to maintain cool outside surfaces especially desirable in flush-to-wall construction.

Approval Requirements for Domestic Gas Ranges specify that maintenance of oven temperature at 300° F. above room temperature shall require not more than 2800 Btu per hour per cubic foot of oven space for insulated ovens and not more than 3900 Btu per hour per cubic foot for non-insulated ovens—tangible proof of the value of insulation. The longer the insulated oven is used at one time, the greater the saving in gas. In some ovens the insulation is of sufficient thickness to permit the gas to be turned off when the cooking process is two-thirds to three-fourths completed, the cooking being finished on retained heat. Other ovens cook almost entirely on retained heat, after an initial heating period of 20 to 30 minutes. (Fig. 88.)



Chambers Corp.

FIG. 88. Heavily insulated oven for baking on retained heat. All handles are self-latching.

For any oven to be rated as insulated, the surface temperatures must not exceed the standards of the American Gas Testing Laboratories as given in the table.[1]

	Rise Above Room Temperature (°F.)
Average weighted surface temperature	65
Maximum metal door-panel temperature	95
Maximum glazed oven-door-panel temperature	110
Maximum oven (broiler) side, top, and back temperature	110
Maximum frame temperature	125
Maximum door-handle temperature	40
Maximum thermostat-knob temperature	40

[1] *American Standards Approval Requirements for Domestic Gas Ranges,* p. 49.

If the range complies with these temperatures, it may have the word "Insulated" on the name plate or another plate or on an approved sticker.

Oven light

The oven may be supplied with an electric lamp that is automatically lighted whenever the oven door is opened. Some models have a switch, on the panel carrying the burner valve handles, by means of which the oven light may be turned on at any time so that the homemaker may inspect the progress of the cooking operation. Oven lamps are subjected to a special high-temperature exhaust to improve the operating characteristics and increase the life of the lamp at the high external temperatures involved. The lead wires are welded to the base and are separated from each other by an insulation of asbestos to prevent any loose oxide from causing a short circuit. A special cement that will withstand temperatures up to 550° F. is used to attach the base.

Oven burner

The oven burner is similar in construction to the surface burner. It has a double row of ports on the upper or lower side of the tube, at an angle of about 30° from the vertical, so spaced that the flame runs from port to port when the burner is lighted at one point. The flame must not flash back when the temperature regulator is moved up or down.

A self-latching valve handle is mandatory on all gas ovens.

According to the American Standards Requirements, preheating the oven from room temperature to approximately 400° F. should require an input of not more than 2000 Btu per cubic foot of oven space for insulated ovens and not more than 2300 Btu per cubic foot for uninsulated ovens.

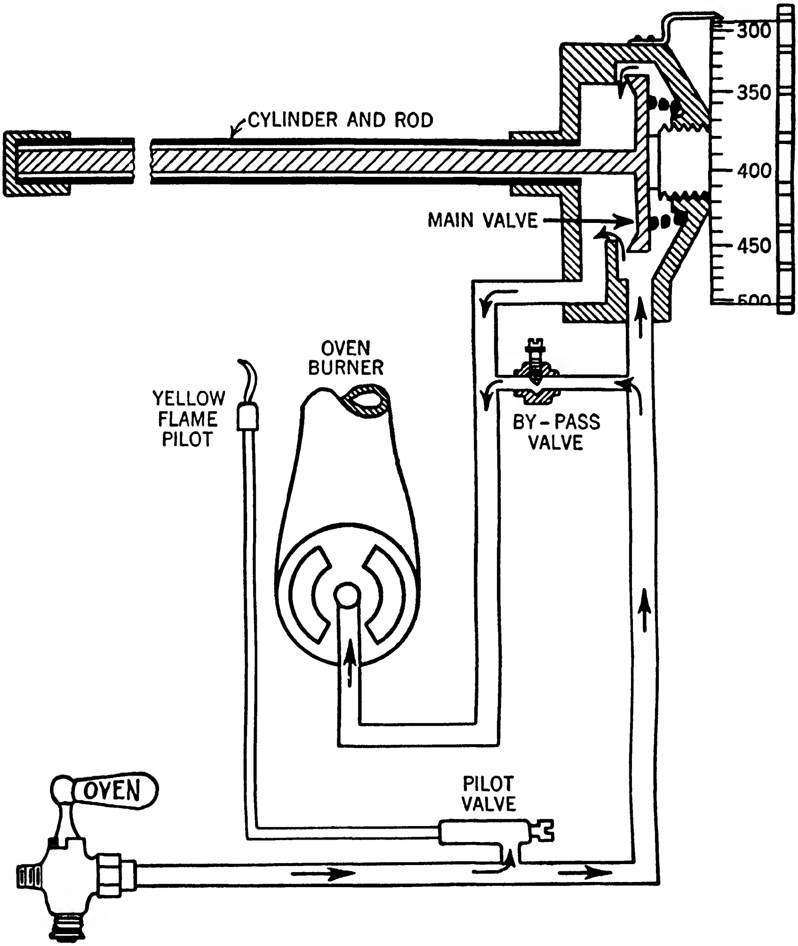
Heat regulator

The heat regulator, by maintaining a constant temperature, is a great aid in the efficient use of the oven. It eliminates the necessity of watching the baking process, reduces poor products and gas consumption, and saves time and energy.

A thermostat has two principal parts: the wheel device, marked in degrees and often also in intensities of heat, outside the oven; and an enclosed liquid, vapor, rod, or a metal strip, sensitive to variations in

temperature, on the inside. A pointer on the wheel is rotated to any desired setting on the dial.

The rod type is illustrated in Fig. 89. A cylinder of metal, usually copper, surrounds a rod of a material having a different expansion



American Gas Assoc.

Fig. 89. Rod-type oven heat control.

coefficient. Porcelain or carbon is frequently used. At the end away from the dial the cylinder and rod are rigidly joined. When the oven valve handle is turned, gas enters the tube and passes up the inlet pipe, through the valve, and down to the burner. As the copper

cylinder expands with the heat, it draws the inner rod with it, releasing the pressure against the spring, which now forces the valve shut to such an extent that only enough gas may pass to maintain the indicated temperature.

A thermostat using a liquid instead of a rod is discussed and illustrated in the chapter on refrigeration (p. 206). Although the form of range installation may be somewhat different (Fig. 90), the principle of operation is similar.

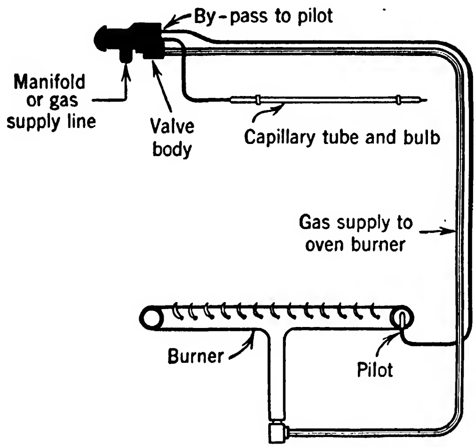


FIG. 90. Thermostat using an expanding liquid.

A thermostat may be operated by a bimetallic strip. The strip transmits its motion to the valve through the rod. In all thermostats, the valve is designed in such a way that practically the full flow of gas continues until the oven temperature is within a few degrees of the reading on the wheel. Since this is true, the preheat period may be shortened by setting the regulator temporarily for a temperature higher than the one desired.

To prevent the flame from being extinguished when the main valve is nearly closed, a by-pass valve always permits enough gas to enter the burner to form a bead flame about 1/8 inch high. The flame must be just large enough to hold the temperature at the dial reading without allowing it to creep gradually higher. It is sometimes difficult to maintain the desired low temperature with a 1/8-inch flame when the oven is well insulated. The flame must not go out if the door is opened suddenly or accidentally slammed shut.

Note that the gas for the pilot comes directly from the main supply pipe and is not affected by the condition of the regulator. The pilot

is a safety device required with thermostats. Sufficient gas passes to keep it burning continuously whenever the burner is lighted. If the burner flame should be extinguished accidentally, the pilot would reignite the escaping gas and prevent an explosion.

New methods of installing oven burners reduce the amount of secondary air so that less gas is required to maintain a given temperature. The oven-heat control works more effectively if the gas valve handle is always turned on full.

When a clock is used with the automatic oven lighter it controls the shut-off valve. The mechanism opens and closes the valve at the times indicated and, with the aid of a second pilot light that heats an expansion element, ignites or turns off the oven burner.

The automatic pilot on automatic ranges is a safety device, and the American Standard Approval Requirements set definite lengths of time within which the pilot shall turn on or close the gas supply. These requirements also include times for the action of the electric pilot igniter in lighting the gas pilot when such an igniter is employed.

Oven heat distribution

The American Gas Association Laboratories test for the heat distribution in a range oven of specified size by baking four plain layer cakes or twelve cookies, and they require that the cakes baked at 375° F. (±10° F.) shall be evenly browned within 25 or 30 minutes, and the cookies in not more than 11 minutes. The laboratories measure the brownness by means of a standard reflectance meter and have set definite limits within which the degree of browning must fall to permit the gas range to display the A.G.A. Approval Seal (p. 163). Baking of other types of food has verified the conclusion that a range that will bake the cake and cookies satisfactorily will bake other foods equally well.

When satisfactory baking results are not obtained, a number of things may be the cause. The kind of pan used makes a difference. As noted in the chapter on kitchen utensils (p. 32) foods baked in enameledware and glass bake faster than those in aluminum or shiny tin, and either the baking time or temperature must be reduced. Size of pan is important. Too little batter in a pan will cause the cake top to be light in color. Pans or cookie sheets must not interfere with the circulation of air in the oven. Free circulation is most easily obtained by placing the pans in alternate positions on the racks and by leaving at least 1-inch space between the pans or baking sheets and the sides

of the oven. (Figs. 91 and 92.) Somewhat less space may be left between the pans themselves. When two or three cakes are baked at one time, they are usually browned more evenly than when four

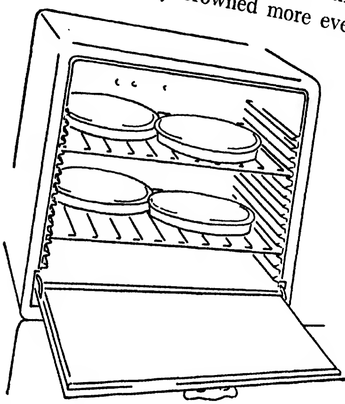


Fig. 91. Incorrect arrangement of baking pans.

cakes are baked together. A single pan should be placed on the middle or top rack and toward the back of the oven to benefit from the circulation of warm air toward the vent.

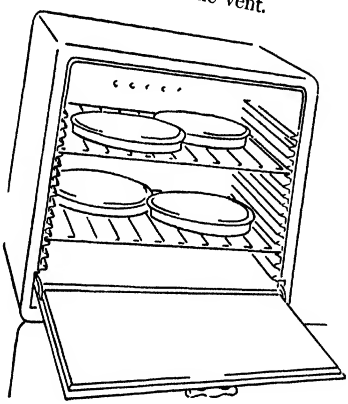


Fig. 92. Correct arrangement of baking pans to obtain free circulation of heat.

Accurate baking temperatures are essential. Too high a temperature causes the cake to be compact in texture with a cracked upper crust; with too low a temperature, the cake has a coarse texture and

frequently a soggy layer at the bottom and a sticky, pitted top surface. Increasing the baking period for a few minutes tends to give more uniform browning on both top and bottom crusts.

The range should sit level. Even slight tilting from front to back, or vice versa, upsets heat distribution and causes uneven browning. A warped oven rack may have the same effect. Incorrect primary air adjustment disturbs the distribution of heat, and any leakage of air around misfitting doors affects the path of flue-gas travel and seriously alters heat distribution. All these points should be checked when baking results are not satisfactory.

Loading the oven to capacity results in efficient use of gas. Dorothy Shank's tests carried on in the research laboratory of the American Stove Company showed that meat, vegetables, and potatoes, cooked in the oven at the same time, used only 10 per cent more Btu than the meat cooked by itself. Meat, vegetables, potatoes, muffins, and a dessert consumed only 15 per cent more Btu than meat alone.

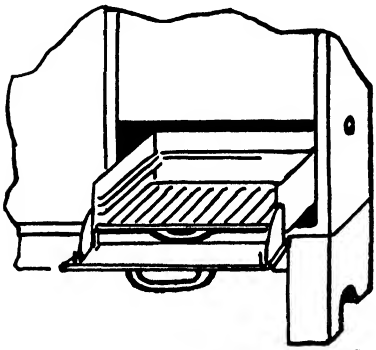
When a whole meal is prepared the arrangement of pans is less important than when cooking baked products, since the food for the meal is not cooked by dry heat but by steam. Experiments conducted in the household equipment department at Iowa State College indicate that baking of many food products may be started in a cold oven, although the saving in time and fuel consumption is negligible.

Broiler

With increasing emphasis on the dietetic value and attractiveness of broiled foods, the broiler is becoming a necessary feature of the range. When heated by the oven burner it is frequently of the drawer type with a front panel that drops down, allowing the pan to be pulled out away from the flame during loading and the turning of the food. (Fig. 93.) A series of glides allows the broiler pan to be placed at any desired distance from the flame. In some ranges the pan may be raised or lowered by turning a handle on the panel. With a separate broiler burner, the pan is sometimes attached to the door of the compartment and swings out when the door is opened. (Fig. 94.) The pan should have a rack of aluminum, porcelain enamel, or chromium-plated steel, perforated with tiny holes or narrow slits, and so constructed that drippings will not spatter or catch on fire. A broiler pan of cast aluminum may be preheated so that both sides of the food are seared at the same time. Various devices are used to increase the amount of radiant heat. One manufacturer has installed unglazed porcelain blocks, completely covered with conelike pro-

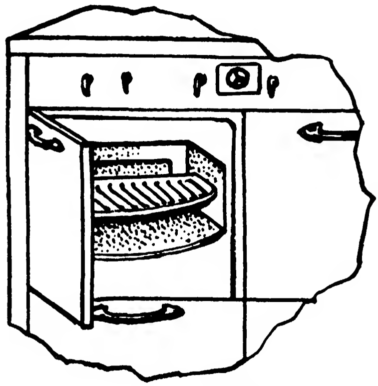
jections, on either side of the broiler burner. These cones are heated to a glow stage by the burner unit and give off radiant rays to the food. Another company uses steel nail heads between and around the burner ports. These become red hot and radiate heat.

American Standard Requirements state that the broiling area shall be centrally located with respect to the burner, the distribution of heat shall be uniform over the entire broiling area, the gas input shall be regulated to maintain temperatures of 430° F. (±5° F.) above



American Stove Co.

Fig. 93. Pull-out broiler.



American Stove Co.

Fig. 94. Swing-out broiler.

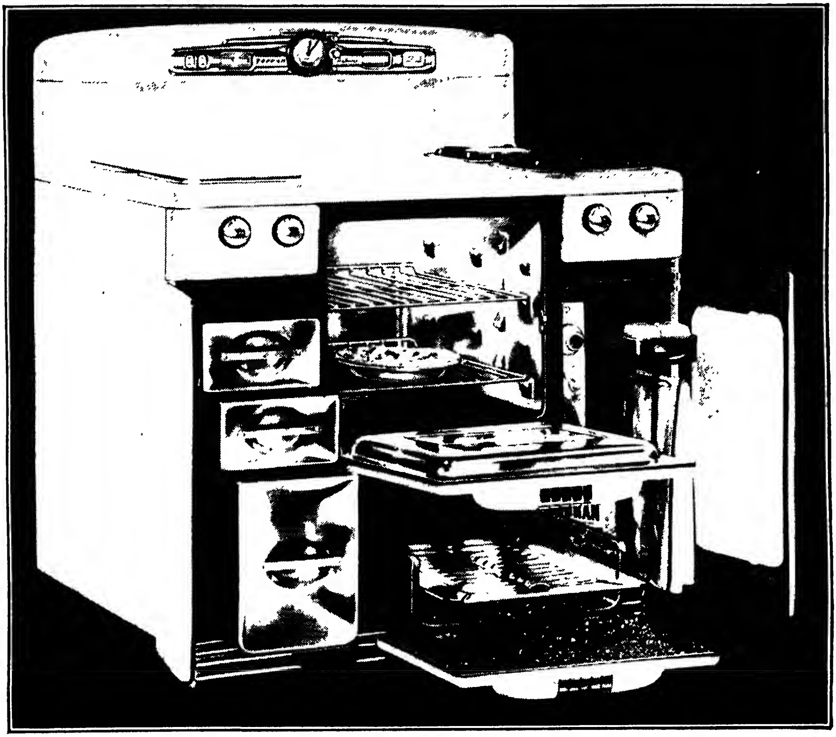
room temperature (i.e., approximately 500° F.), and the temperature of the broiling compartment shall reach 530° F. above that of the room within 16 minutes. Broiling spaces are vented, but usually any smoke or volatile fats from the broiling process are consumed as they rise into the gas flame. In one gas range the entire broiler carriage may be removed for cleaning.

Other features

Less essential but very convenient features are found on many of the gas ranges—a folding top over surface burners, utensil drawers, broiler and storage drawers on roller bearings, an oven light, oven racks that may be pulled out without tipping. (Fig. 95.) Some ranges have self-latching burner valve handles which lock automatically when closed. (Fig. 88.) These safety devices are especially valuable where there are small children.

An indicator may tell when surface burners or oven burners are operating or the preheat period is finished; a light may be installed

above the back guard to illuminate the range top. Convenience outlets are also frequently provided, and one company controls the outlet with a clock that may be set for varying lengths of time. Other optional features are discussed in the following paragraphs.



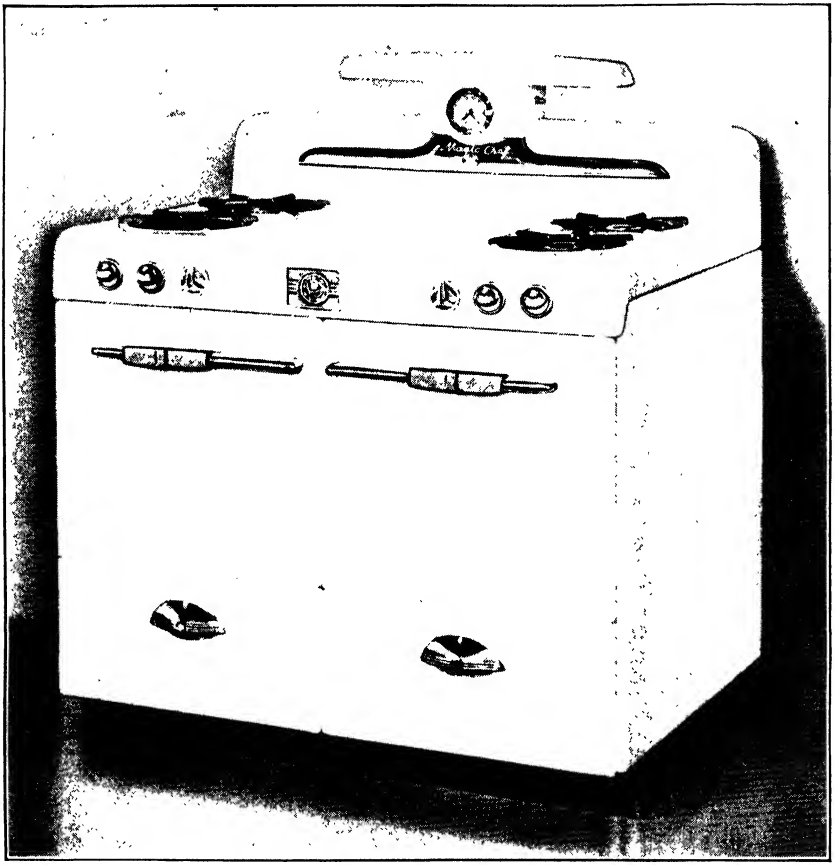
Tappan Stove Co.

Fig. 95. A gas range with a variety of storage space. On the back guard are two convenience outlets—one connected to the timer—a minute reminder, an oven clock control, and indicating lights.

The "CP" range

In 1938 a number of companies, members of the Gas Appliance Manufacturers Association, began the manufacture of "CP" ranges, which gave high operating efficiency at lower operating cost. New minimum requirements for these automatic ranges built to "CP" standards went into effect January 1, 1947. (Fig. 96.) Seventeen specifications have been set up that provide certain standards in addition to the basic safety and performance standards required by the American Standards Association and the American Gas Association

Laboratories. The requirements are classified into convenience, performance, and efficiency features of top burners, of oven, and of broiler. They include: automatic ignition for all top burners, rust-



American Stove Co.

FIG. 96. A "CP" range. Note the extension of the platform over the front edge to the top of oven and broiler.

resistant burner heads, one or more high-speed top burners with an input rating of 12,000 Btu per hour and an output capacity sufficient to raise 5 pounds of water 140° F. in 9 minutes or less, standard top-burner efficiency of 45 per cent or above, two-way burners for simmering, oven thermostat, automatic oven lighting, maintenance of oven temperature of 250° F., oven vent directing flue vapors away from rear wall, automatic broiler lighter, minimum effective broiling area

not less than 0.8 square foot or 80 per cent of grill area, whichever is greater, smokeless broiler pan, quiet operation of all drawers without undue friction or jamming, stops on all drawers and racks, and the A.G.A. Approval Seal. All "CP" ranges, with the exception of bungalow and combination ranges, must fit flush to the wall.

In addition to the fundamental requirements, "CP" ranges may have a deep-well cooker, an oven clock control, and a minute reminder. In place of the well cooker some ranges feature a well roaster, useful when a small amount of food is to be baked.

Gas Appliance Manufacturers Assoc.

FIG. 97. "CP" trademark.

"CP" ranges are marked with the special symbol, "CP," in addition to the A.G.A. Approval Seal. (Fig. 97.)

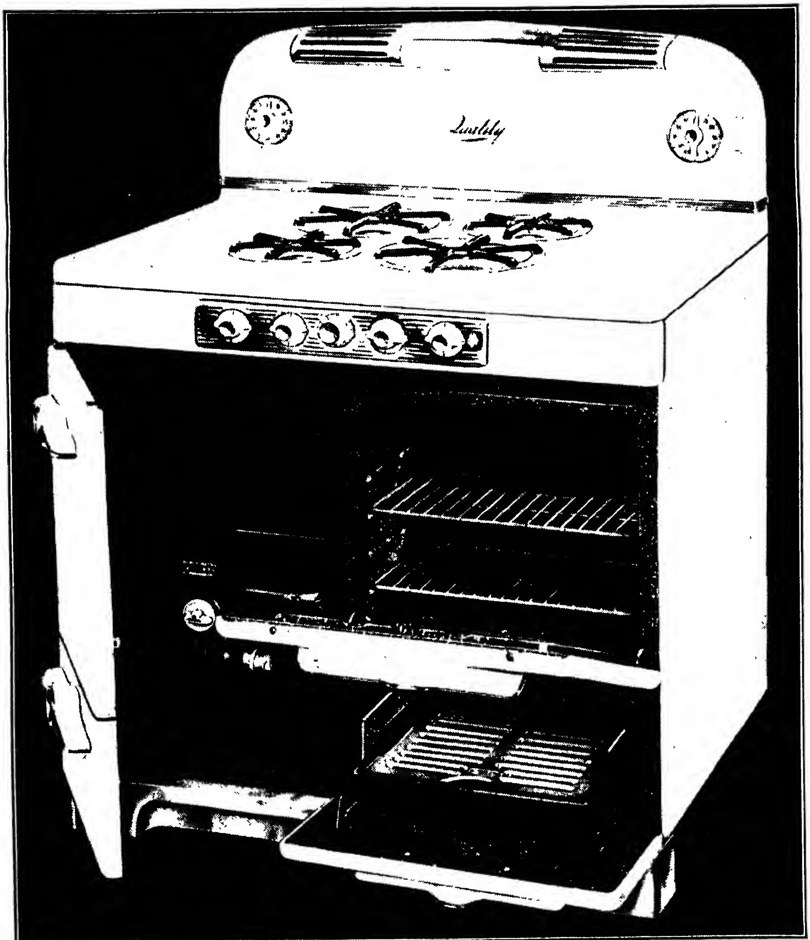
Bungalow range

In homes without a central heating system a bungalow range is sometimes used to warm the kitchen as well as provide means of cooking. This range has a gas room heater as a part of its standard equipment. The heater occupies space at the side of the oven behind a perforated end panel through which the heat flows into the room. An automatic valve to turn the gas on and off is controlled by a thermostat set for the desired room temperature. Such an arrangement makes for efficiency and ease of operation. The rest of the range is similar in construction to other gas ranges. (Fig. 98.)

Care of range

At present most gas ranges are finished in porcelain enamel, which is easily cleaned with a cloth dipped in soapy water. Do not wipe the range when it is warm. Enamel is a glasslike coating fused on an iron or steel base and, if washed when hot, will cool more rapidly than the steel and tend to crack because of the unequal contraction. Cleaning powders scratch both porcelain enamel and chromium, sometimes used for trimmings and oven linings. The racks, rack glides, and oven bottom may be taken out and washed. Obstinate spots can usually be removed with baking soda or kerosene.

Rusting in ovens may be checked by leaving the oven door open for a few minutes when the gas is first lighted, to permit moisture to escape, and again at the end of the baking period until the oven has



Roberts and Mander Corp.

FIG. 98. The bungalow range, with kitchen space heater at the left.

cooled. Moisture from the combustion process tends to condense in the cool oven before proper circulation has been established.

Greater efficiency is obtained if burners are cleaned regularly. They should be removed from the range, all dust and food particles brushed from the top and mixing tube with a stiff brush, and the

air shutter cleaned. Sometimes it becomes necessary to boil the burners in a solution of washing soda (1 tablespoon of soda in 3 quarts water). Aluminum burners must not be treated in this way since alkalies tend to darken aluminum, but they may be washed in warm soapy water and rinsed in clear hot water. Before replacing, dry the burners upside down in a warm oven. The pilot-light valve may be carefully cleaned with a piece of wire. It can be damaged if roughly handled.

After broiling, wipe off spatters of fat with a piece of soft paper before washing; fat that has burned on may be rubbed with steel wool of a fine grade. When a bad spill-over has burned on the oven bottom and is not easily removed with soap and water, a clean piece of old toweling or cheesecloth may be wet with household ammonia and placed over the bottom plate. If the cloth is left until dry, the burned-on material has usually loosened and may be removed by washing. If the broiler is not used when the oven is heated, the pan may be removed.

A.G.A. Approval Seal

Most manufacturers submit their gas appliances to the American Gas Association Laboratories for testing. Requirements for gas ranges have been worked out by committees on which are representatives from the National Bureau of Standards, U. S. Bureau of Mines, U. S. Public Health Service, U. S. Bureau of Human Nutrition and Home Economics, American Home Economics Association, U. S. Department of Agriculture, Canadian and American gas associations, and others. The committees have set up minimum requirements for safety, efficient performance, and durability. These requirements include gauge of metal used for the different parts; regulations as to flues, burners, valve handles, ovens, etc.; essential conditions of gas consumption; protection against gas leakage, production of carbon monoxide, and fire hazard; and satisfactory testing of distribution of oven heat and thermal efficiency of top burners. Judgment for or

American Gas Assoc.

Fig. 99. The Laboratories Approval Seal.

against is impartially determined. If a range meets the requirements the manufacturer is required to mark it with the A.G.A. Approval Seal—a blue star, surrounded by a double circle, in which appears the following statement, "Complies with National Safety Standards, Approved, American Gas Association." (Fig. 99.)

Suggestions for the economical use of gas for cooking

In the purchase of any piece of equipment, initial, repair or upkeep, and operation costs must be considered. Most gas appliances are of simple construction, and repair costs are, consequently, very slight. Operation costs depend upon local gas rates, but they may be greatly reduced by the efficient use of the appliance.

1. Have flames properly adjusted.
2. Keep all parts clean.
3. Use an oven regulator to maintain oven temperature.
4. Use small burners instead of a large one.
5. When water begins to boil, turn flame down or preferably to simmer position, if simmer-type burner is available. Slow-boiling water is as hot as rapidly boiling.
6. Do not light gas before needed. Gas is as hot the instant it is ignited as 10 minutes later. Place pan over burner before turning on the gas.
7. Turn off gas and relight again if there are to be some minutes when it is not in use.
8. Use covered utensils whenever possible.
9. Boil only amount of water needed.
10. Do not preheat oven too long before use. Do not peek while food is baking.
11. Use oven to capacity.
12. When oven is well insulated, turn gas off a few minutes before end of bake period and finish cooking on retained heat. If available, use well cooker for long cooking processes or when several foods are cooked together.

Summary

1. Ranges may be classified as open, semienclosed, and closed top.
2. The gas passes through the manifold, gas valve, and orifice into the mixing tube of the burner, where it mixes with primary air drawn in through the shutter, then flows from the ports, and is ignited. The

additional oxygen required for combustion is supplied by secondary air.

3. Surface burners are of three sizes: giant, 12,000 Btu heat capacity per hour; regular, 9000 Btu; simmer, 1800 Btu. A lower adjustment of the simmer burner is used to keep foods warm.
4. Flame from the 45° angle port or horizontal slit rises an inch or two above the grate and spreads uniformly over the bottom of a utensil placed over it.
5. A closed top should not be placed on an open-top range without the approval of the gas company.
6. Ovens are of two types, semidirect and circulating. Insulated ovens are recommended. The vent is placed to direct flue vapors away from the wall.
7. Thermostatic control of the oven saves gas and the time of the homemaker and gives more uniformly baked products. The regulator is made of two metals that expand at different rates when heated or is a tube containing liquid that changes to a gas. In either type the flow of gas to the burner is regulated to hold the temperature of the oven approximately constant.
8. To render efficient service, gas ranges should be kept clean and adjusted.
9. The American Gas Association Laboratories have set up minimum safety, durability, and efficiency requirements for all gas appliances. Appliances conforming to these minimum requirements are stamped with the American Gas Association's approval seal.
10. The "CP" range must fulfill seventeen requirements and may include optional features. It is marked with a special symbol, "CP," a trade mark of the Gas Appliance Manufacturers Association.

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8

Coal and Kerosene Ranges

THE RANGE IS USED three times a day in more than 26,000,000 American homes. The choice of a fuel is, therefore, of no small importance. Although the homemaker would doubtless prefer to use a fuel that requires no storage or handling, and consequently reduces the time spent in the care and cleaning of the range, choice depends primarily upon availability and cost. Because of the necessity of taking these factors into consideration, solid and liquid fuel ranges are still extensively used.

THERMAL AND OPERATING EFFICIENCIES

The thermal efficiency of a fuel depends primarily upon the extent to which the carbon and hydrogen are oxidized. Maximum heat is obtained only with complete combustion. Methods of oxidation are contingent upon the type of appliance, and it is, therefore, impossible to separate the fuel from the equipment in which it is burned.

Thermal efficiency, however, should not be confused with operating efficiency, which takes into consideration the speed of performance.

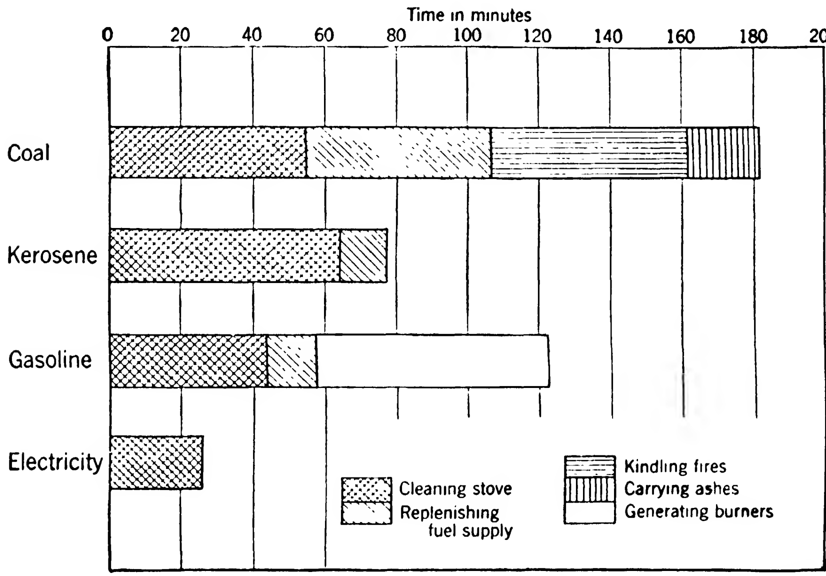
TIME FOR CARE

In 1929 to 1930 the Home Economics Department of Purdue University made a survey of fuels used for cooking purposes in Indiana rural homes. Figure 100, taken from that report, shows the time spent per week in the care and cleaning of the ranges.

WOOD AND COAL

Wood is used in rural sections where home-owned wood lots or ample local supplies make the cost comparatively slight. Coal has been, and in the United States will probably continue to be, a main source of heat and power. Twenty times as much coal per capita is consumed at the present as was consumed in 1850. The United States has 52 per cent of the world's supply, widely distributed, with the anthracite largely in Pennsylvania and West Virginia and bituminous beds in many of the states. Coal is available to all homes, except comparatively few located at a remote distance from railroads. It

is delivered to the house by truck load or in bags, and it requires both storage and handling. The removal of ashes produces dust and dirt. When coal is the fuel, more time is spent in kindling the fire, replenishing the supply, removing ashes, and cleaning the range than when any other fuel is used, but, with the exception of natural gas, it is the cheapest of fuels. Efficiency of anthracite for cooking is low, only 5.3 per cent, the Purdue investigation showed.



Agric. Exp. Sta., Purdue University

FIG. 100. Time spent per week in care and cleaning of cooking stoves.

COAL RANGE

The modern coal range is attractive in appearance. Coal ranges are made of cast iron, malleable cast iron, and steel, usually finished in porcelain enamel. No one range is made entirely of a single material. Eighty to ninety per cent are made with cast iron for the body and oven and steel for the back guard and reservoir box. The reservoir itself is of porcelain enamel on steel or of copper. If body and oven are of steel, it must be heavy gauge and should have porcelain enamel on both sides to resist corrosion. Malleable cast iron cannot be enameled.

When ranges are of cast iron, or cast iron and steel, the parts are usually bolted together. The unions cannot be made entirely tight and are filled with stove putty, which cracks and falls out with con-

stant heating, leaving openings through which air leaks may occur. Such cracks should be filled with furnace cement. Ranges of malleable cast iron and steel have the joints riveted or welded and should remain tight permanently.

Top surfaces of cast iron may crack if permitted to become red hot or if subjected to sudden changes in temperature, e.g., when a kettle of cold water is placed on a hot lid. Under the same conditions malleable iron tends to warp. If the casting is sufficiently thick and

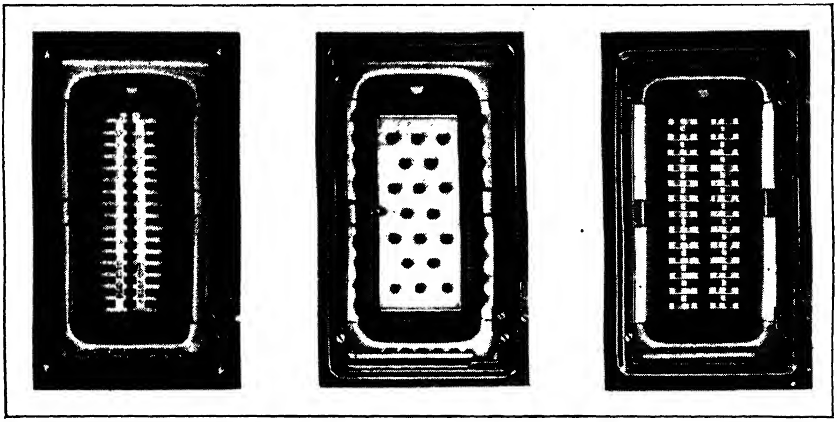


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Fig. 101. Grates and linings for use with various fuels.

Left: Duplex grates with cast iron linings; best for soft coal and small-size hard coal. *Middle:* Flat wood grate with cast iron linings; best for holding embers of wood fire. *Right:* Triplex grates with firebrick linings; best for large-size hard coal.

allowance is made for expansion and contraction, cracks and warping usually do not occur.

The firebox may be lined with firebrick or cast iron, but the grates are always of cast iron since this material most successfully withstands direct contact with flame and intense heat. Firebrick linings are used with anthracite coal of the larger sizes; the cast-iron linings with pea and other small-size hard coals and with soft coal and wood. Clinkers do not adhere so readily to cast iron as to the firebrick, and the iron linings are not easily broken when stoking with wood. The grates illustrated in Fig. 101 have been adapted for use with the fuels specified and give most satisfactory service when purchased with the definite type of fuel in mind.

The size of the firebox will depend upon whether coal or wood is used. It should be 18 to 22 inches long to accommodate sticks of wood, with a grate, 7 to 9 inches wide, for coal. Some grates are reversible, for efficient use with either fuel. If well constructed, a

weight of about 10 pounds is sufficient to prevent the grate from burning out or warping. The lining weighs approximately 40 pounds more. Space behind the lining for ventilation increases durability.

A large firebox requires more coal but lengthens the time between refueling. It is usually not necessary to have the box more than half-full even when using the oven. Space above the fire permits complete oxidation of the gases from the coal, a result that is more easily attained if the fire bed is not entirely covered with new coal at one time, but only in part, so that some glowing embers are always exposed. A new range should be "conditioned" by starting the fire slowly for the first two or three weeks.

Ash from coal melts at a high temperature and forms clinker, which may fuse with the firebox lining and damage it. On the other hand, a thin layer of ashes over an iron grate protects it from overheating, but ashes should not be allowed to accumulate beneath the grate. The ash compartment should be designed to prevent ashes from falling outside the pan, and the pan itself should be removable without spilling.

Cast-iron ovens do not heat as rapidly as those of steel, but they retain the heat longer. The door should be insulated with a packing of asbestos or rock wool to protect against burns, and insulated walls help in maintaining more even temperatures. Ovens are surrounded by a system of flues, through which the hot air circulates.

Coal contains an appreciable amount of moisture, varying from a small percentage in anthracite to as high as 24 per cent in subbituminous coal. This moisture passes off in the form of steam and tends to condense in the flues as the range cools, causing the inside walls to rust. Various finishes have been used in an attempt to protect the flues. Vitreous enamel, fused upon the flue castings, has proved to be one of the most effective.

A heat indicator in the door should be accurate to within $\pm 30°$. The handle is usually of nickel or chromium, and may be of plastic, which is cooler to the touch. Racks should be sturdily built, rust-resistant, non-tipping, and easily removed.

Coal burns slowly because it does not form an intimate mixture with oxygen. Kindling is necessary to start combustion. Products of combustion are carbon monoxide, carbon dioxide, nitrogen, excess oxygen, and free carbon. Anthracite is low is ash and volatile constituents and high in percentage of fixed carbon. It is preferable to bituminous coal for the kitchen range.

All coal ranges must be connected to a chimney, through which the smoke and any unburned fuel gases are expelled. The air in the chimney is warmer than the outside air and consequently produces a draft. For this draft to be as effective as possible there must be a continuous airtight passageway free from all obstructions from the opening below the firebox, through the grates and flues, to the top of the chimney. There should be no leaks around any of the openings into the chimney or between the bricks of the chimney, and all stovepipe joints must be tight and have as few bends as possible.

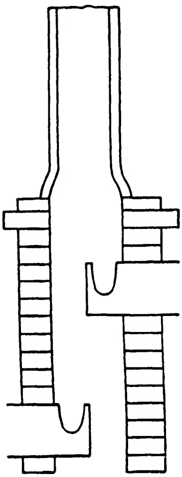


FIG. 102. Correct arrangement when two chimneys are connected to one flue.

The end of the stovepipe should be flush with the inner wall of the chimney unless a second pipe enters the same chimney, when the arrangement shown in Fig. 102 is recommended. The distance between the two pipes should be at least 8 inches, preferably more. The chimney should extend not more than a foot below the stovepipe and a minimum of 20 feet above the pipe, higher if close to tall trees or neighboring buildings.

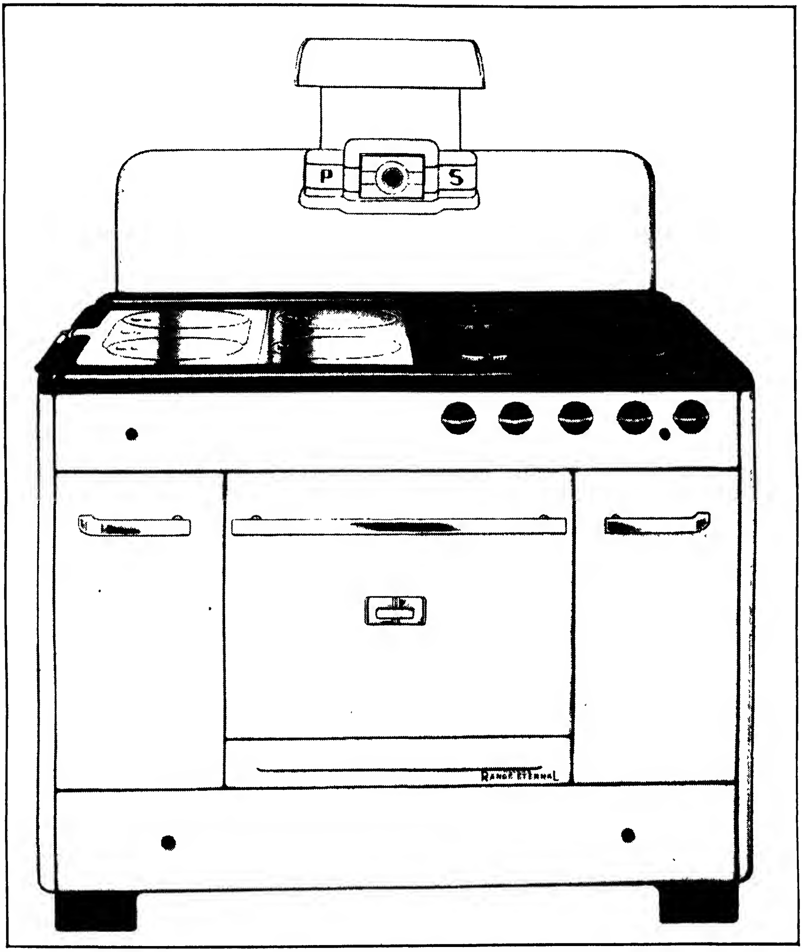
Burners that use either kerosene or fuel oil may be installed in place of the firebox. They eliminate the dirt and bother of coal or wood and supply at reasonable cost a steady source of heat for surface cookery and baking. The fuel tank may be placed in the kitchen, or a smaller tank may be attached to the back of the range and connected to a storage reservoir outside the house. A system of valves makes the service almost automatic.

Monroe found that the proper positioning of the burners in the firebox was important. To obtain desirable baking temperatures, the center of the burner assembly should be approximately on a level with the center of the oven. The top of the burner sleeve should never be higher than the top of the oven and preferably $1\frac{1}{2}$ to 3 inches lower. When kerosene is burned, a minimum draft should be maintained. Monroe reported that cakes and bread baked more evenly when placed on the bottom of the oven. About $\frac{7}{8}$ quart of kerosene was burned per hour to maintain the air at the bottom of the empty oven at 350° F.; more would be used in baking food.

COMBINATION RANGES

Rural homemakers are interested in the flexibility of electricity and the LP gases for cooking but, when central heat is not available,

have hesitated to give up the coal range because of its usefulness in heating the kitchen during the winter. The bungalow range has been one solution to the problem; the combination range is another. (Fig. 103.) The combination may be coal (wood or cobs) with gas or with



Allen Mfg. Co.

Fig. 103. Combination gas and coal or wood range.

electricity. Approximately half of the top surface is heated from the firebox and the other half is fitted with gas burners or electric units. The oven may be heated by the combination fuels or entirely by the controlled fuel. Baking in an oven controlled by a thermostat has

many advantages. The oven thermometer is at best only an indication of temperature and not a control. Tests on combination ranges made in the household equipment laboratory at the Iowa State College showed that the oven-door thermometer reading tends to lag behind the true oven temperature. When the oven is heating, the inside temperature is higher, for a half hour or more, than the thermometer registers. In cooling, the reverse is true; the thermometer indicates a higher temperature than is maintained in the oven.

These experiments indicated, however, that food may be cooked satisfactorily in a combination oven and that part of the preheating may be done with cobs or wood before the automatically controlled fuel is turned on. The position of food in the oven may vary somewhat with the two fuels. The chief difficulty encountered in the use of combination range ovens was the need of installing or removing a burner or baffle in changing from one fuel to the other.

Heat radiated from the coal range makes its use in summer very undesirable.

To keep iron or steel portions of the range free from rust and pleasing in appearance, a rub with a cloth moistened with light machine oil is recommended rather than blacking. Porcelain enamel and the metal trimmings are cleaned in the same manner as on other ranges.

Kerosene

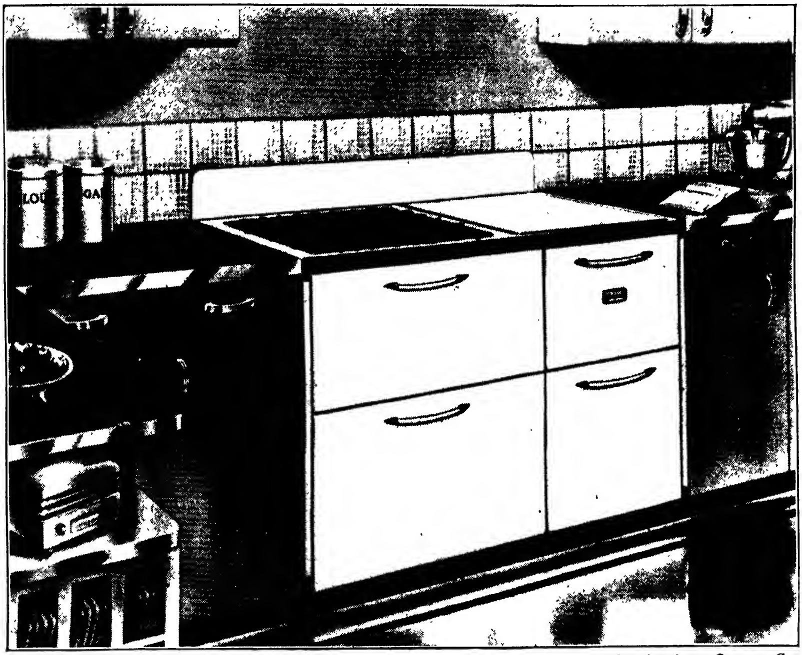
Kerosene and gasoline are different fractions obtained from distilling and refining crude oil found in pools in several widely scattered areas in the United States. Gasoline distils off at a comparatively low temperature; at a higher temperature the kerosene, and still higher, heavy fuel and lubricating oils come off.

Kerosene was obtained from the oil wells after such sources were accidentally discovered in 1859, but before that time it had occasionally been found in natural oil springs and had been made from coal and shale.

For home use, kerosene is delivered by can or tank, and storage and handling are necessary. Ranges are usually supplied with containers holding about 1 gallon, but they may be connected to outside tanks of much larger capacity. Time is required for filling the container and for the care and cleaning of the burners and range, if smoke and odors are to be prevented. Kerosene has a heat value of 133,000 Btu per gallon and a thermal efficiency of 16 to 33.5 per cent.

KEROSENE RANGES

Kerosene is widely used in homes where gas and electricity are not available, especially as a summer fuel; more than 70 per cent of the rural homes included in the Indiana survey reported the use of kerosene for cooking in the summer months. Although, with the ex-



Perfection Stove Co.

FIG. 104. The modern kerosene range fits easily into the modern kitchen. The burners and tank are concealed.

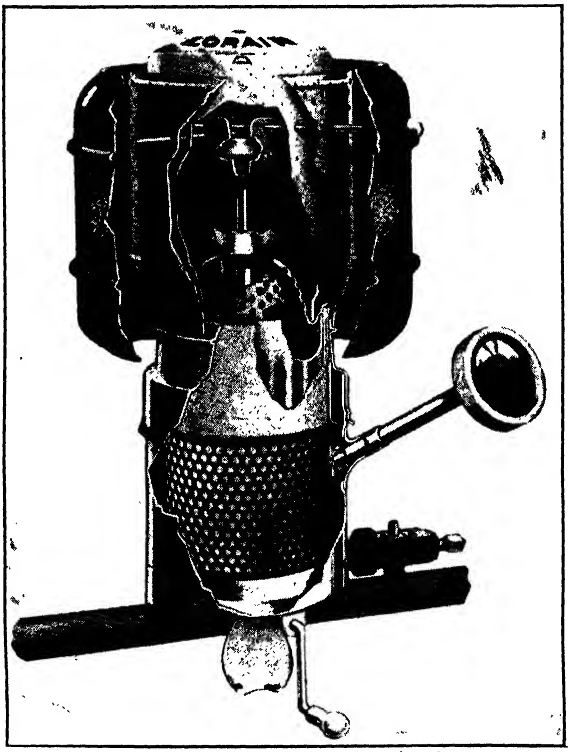
ception of coal, the amount of kerosene consumed, expressed in British thermal units, was higher than the amount of other fuels consumed, the actual cost was the lowest.

Modern kerosene ranges are similar to other ranges in appearance. Some are table-top models; others have the elbow-high oven. Usually the fuel tank is concealed behind the frame panels. (Fig. 104.) Separate reservoirs for surface and oven burners are sometimes furnished. Ranges have two to four burners for surface cookery and two additional burners to heat the oven. The oven burners may be on a sliding rack for ease in lighting. On certain stoves the burners are staggered, furnishing space for large utensils.

To burn, kerosene must be changed to a vapor, a change made possible by the form of the burner. Heat is carried to the utensil chiefly by convection currents, and a certain amount is lost in the process. Manufacturers attempt to reduce the loss to the minimum by the construction of the chimney. Burners are classified as short-chimney, long-chimney, and asbestos-ring or wickless. The short chimney has a comparatively small area of exposed surface, while the long chimney protects the flame, decreasing heat loss. Enclosing the back and sides of the stove increases burner efficiency by cutting off drafts.

SHORT-CHIMNEY BURNER

The lower section of the short-chimney burner (Fig. 105) has a wick tube of brass, in which the wick carrier with the wick is raised or

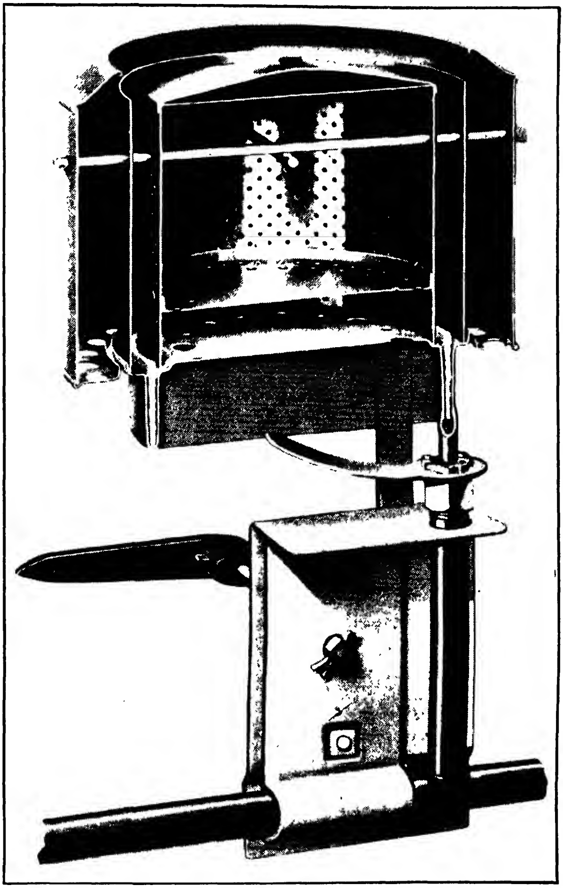


American Stove Co.

FIG. 105. Short-chimney burner.

lowered by a brass ratchet wheel at the end of an adjusting rod. The rod is controlled by a handwheel at the outer end. The inner wall of

the wick tube is corrugated to allow the wick to be adjusted with the minimum amount of friction. The wick chamber surrounds a central shaft at the top of which there is a perforated automatic wick stop



American Stove Co.

FIG. 106. Asbestos-ring burner.

held in place by a lock nut. The wick stop permits the wick to be turned to the correct position for lighting and burning and also provides for circulation of air. A removable head on the wick chamber increases the ease with which wicks may be replaced.

The upper part of the burner consists of an inner and an outer perforated combustion tube surrounded by a chimney of porcelain enamel to which the tubes are securely fastened. In the past, the

inner tube has tended to burn out owing to the high temperature produced, but at least one manufacturer now makes this tube of heat-resisting stainless steel that carries a 10-year guarantee. The combustion tubes are tapered at the bottom to prevent boiled-over food from reaching the wick. This upper section rests on the top of the central shaft.

When not lighted the chimney section is raised from the wick chamber by a handle at the base of the wick tube. The chimney should always be raised when the flame is extinguished; otherwise oil tends to seep out of the wick tube and spread over the outside of the wick chamber. When this occurs, the relighted burner will smoke until the oil has burned off.

Kerosene burns in the short-chimney burner with a clear blue flame that extends above the combustion tubes and strikes directly against the cooking utensil. The oil is vaporized by the heat in the wick and rises into the flame, which increases in size for the first 5 or 10 minutes and must be lowered until properly regulated. All flames will grow until maximum heat is reached.

The asbestos-ring type has an inner and an outer combustion tube, fastened to a chimney, as in the short-chimney type, but a ring of asbestos, supported in a metal frame, is used instead of a wick. This asbestos ring rests in a shallow trough which is connected to the feed pipe, and the height of the flame depends upon the amount of oil allowed to flow into the trough. (Fig. 106.)

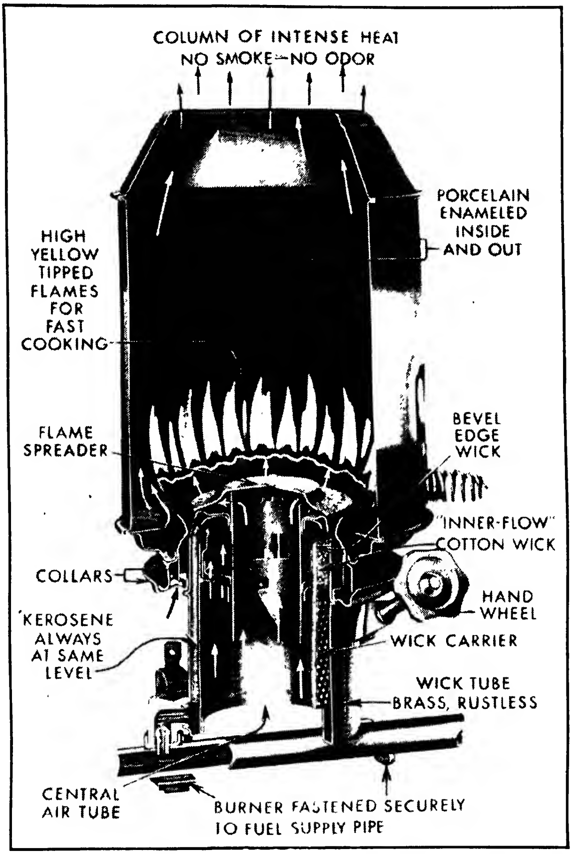
Long-chimney burner

The long-chimney burner differs somewhat in construction from the short-chimney. (Fig. 107.) The lower section has a double-walled brass wick tube with a surrounding removable collar at the top. The inner tube is slightly shorter than the outer tube, and this difference in height gives a bevel edge to the wick. The wick tube is fastened and connected to the feed pipe. A handwheel turns a rachet wheel to move the wick carrier up and down.

In place of the wick stop, the long-chimney burner has a flame-spreader which is held in place by a central shaft. The flame-spreader rests upon a circular perforated plate and is itself perforated on the top and bottom and around the sides, the holes varying from large pinpricks to ¼ inch in diameter. The flanged edge of the spreader is so shaped that it directs the air currents and gives a proper angle to the flame, preventing it from cupping over the top of the spreader. The spreader is not a wick stop, and care must be taken not to turn the wick so high that it rests against the spreader. Some ranges have

a spreader-lift to increase the distance above the wick when lighting the burner.

The chimney is of porcelain enamel with a mica window through which the flame may be seen. Around the bottom are holes to admit



Perfection Stove Co.

FIG. 107. Long-chimney burner. Note the distinct line of separation between the blue body and yellow tips.

secondary air, which absorbs the heat from the flame and decreases heat loss. The diameter and height of the chimney apparently affect the velocity of the air, and the draft is greater in the long than in the short chimney.

Two kinds of flames may be obtained with the long-chimney burner: the blue flame, similar to the one with the short chimney; and a blue flame with yellow tips, 1 to 1½ inches high, above the blue body. There should be a distinct blue line of demarcation between

the body of the flame and the tips. This yellow-tipped flame is hotter than the blue flame alone and reaches maximum heat in about 3 minutes unless the range is abnormally cold. In the long-chimney burner, the vapor is lifted from the wick by the currents of air instead of being driven off by heat, and this accounts for the rapid generation of the flame. The wick should be turned just below the point at which the tips tend to converge. The tips contain some unburned carbon that was not completely oxidized in the body of the flame. As this incandescent carbon rises and comes into contact with the hot air, oxidation is completed and the intense heat is brought close below the utensil. The neck of the chimney is designed to concentrate all the heat at the cooking level. The wick should not be turned to this highest flame until the burner is warm; otherwise a break in the flame may occur, causing oil seepage onto the wick tubes and a disagreeable odor. An automatic wick stop controls the height of the wick for the yellow-tipped flame.

Experiments carried on in the laboratory indicate that the long-chimney burner heats more rapidly, i.e., has higher operating efficiency, whereas the short-chimney has slightly greater thermal efficiency, although it heats more slowly. Similar results were obtained by Snyder at the University of Nebraska. Snyder also found a very direct relationship between the thermal efficiency of any oil range and the distance between chimney top and grate. Up to a certain point thermal efficiency increases and heating time decreases as the distance between grate and chimney top is decreased. When the distance is too short, however, the draft is not sufficient for complete oxidation, soot is deposited, and odors occur.

The giant burner, found on some ranges in addition to standard burners, is 1 to 2 inches larger and heats the utensil more rapidly than the standard burner but is less efficient. Individual differences between ranges having the same type of burner may be as great as between ranges of entirely different types.

Flames are extinguished in oil ranges by turning the wick down into the wick tube or by shutting off the supply of fuel. Oil remaining in the troughs of asbestos-ring burners will continue to burn until wholly consumed, and, if by chance the flame is not sufficiently hot to vaporize all the oil, an odor will be noticeable.

Any kerosene burner, to give satisfactory service, should meet the following requirements: (*a*) it should be quick to develop a steady flow of heat; (*b*) it should perform the operation of heating rapidly; (*c*) it should not be extravagant in the use of fuels; (*d*) its provision for draft should be such that the fuel is completely oxidized to prevent objectionable odor and the

formation of soot; (*e*) the burner should be simple to operate and easy to clean.[1]

Level range necessary

The kerosene range should stand level; otherwise the burner farthest from the oil reservoir will be flooded or will tend to burn dry and consume the wick unnecessarily, depending upon the direction of tip. The asbestos-ring type must be level. If the reservoir becomes empty when the stove is in operation, all the burners will burn dry. A detachable reservoir is preferable, and, when it is of glass, the amount of fuel is easily noted.

Care of range

The fuel pipes should be drained and cleaned once in three months, or oftener if the kerosene contains water. When water gets into the wicks they will burn with a sputtery flame or the flame will have gaps. The end of the fuel line away from the reservoir has a removable cap. After the reservoir has been removed this cap is taken off, and the opposite end of the stove lifted so that the oil may drain out. A stiff wire is run through the pipe to clean it, and it is rinsed out with fresh oil.

Wicks are an important part of the oil range. They are made of closely woven high-grade cotton, so constructed that the oil is broken up into tiny particles and drawn up through the capillaries of the wick to the top, where it may be ignited with a match. One wick has an intermediate third ply of vertical threads which shortens the path of the oil and lessens the tendency to ravel. Wicks should be kept in condition by frequent cleaning, usually as often as once a day, though some authorities suggest once for every 12 hours of burning. To clean the wick, the chimney, outside collar, and flame-spreader or wick stop must be removed, the wick turned level with the top of the wick tube, and wiped with a piece of soft cloth from the center outward, until free from the charred edge. Any loose threads may be cut off with scissors, but scissors are not used for other trimming. Very uneven wicks may be burned off by lighting the burners with the reservoir tipped back. The charred edge is then wiped and smoothed with the fingertips. If the wick has a beveled edge, this should be carefully maintained.

Some makes of ranges are provided with a wick cleaner—a metal ring which fits down over the wick and is turned to right and left to remove all the char from the edge.

[1] Edna B. Snyder, *A Study of Kerosene Cook Stoves*, p. 5.

When the wick has burned down to the carrier, it must be replaced. Long-chimney ranges will use one set of wicks for about a year; short chimneys require more frequent replacement of wicks, sometimes as many as four sets a year; lighting rings do not burn out but will need to be replaced unless cleaned regularly. Always buy wicks made especially by the manufacturer for the stove in use. Wicks are burned off at the factory to prepare them for lighting and should not be confused with old wicks. Before lighting, new wicks should be turned down into the wick tube for 5 minutes to become saturated with oil.

Perforated sections should be brushed free from dust, which will impede air circulation. Occasionally they may be boiled in a soda solution and carefully dried. Oil spreads in a thin film so that any seepage over the edge of the wick tube must be wiped off to prevent smoke and unpleasant odors. Some grades of kerosene contain heavy oil which may drop out of the flame and condense on the wick tube.

Oil ranges have only a few parts to get out of order, and any needing to be replaced can usually be purchased at the local hardware store. It is well to select a range for which parts are easily available.

Ovens

Ovens frequently have insulated walls and temperature indicators and some have patented accessories for distributing the heat evenly. Portable ovens, used with certain ranges, are often constructed with heat-resistant glass windows in the door so that the progress of the baking may be noted. After manufacture, portable ovens are usually oiled to prevent rusting. When first heated this oil burns off and may cause smoke.

Safety of kerosene

The accepted chemical formula for kerosene is $C_{13}H_{28}$. A temperature of approximately 700° F. is required to separate the carbon and hydrogen atoms. Kerosene is not volatile at room heat and for this reason is considered a comparatively safe fuel. Gasoline is much more volatile and if mixed with oil in the reservoir of an oil stove will cause an explosion.

Summary

1. Coal ranges should be constructed with warp-proof unions and rust-resisting flues.
2. There should be a continuous airtight passageway from the opening below the firebox to the top of the chimney.

3. Combination ranges use coal and gas or coal and electricity for cooking. The oven may be heated with either fuel or only with the controlled fuel. This range is especially adapted to the home without a central heating system.
4. Burners on kerosene ranges are short- or long-chimney and asbestos-ring (wickless) types.
5. The long-chimney type has the higher operating efficiency; the short, the higher thermal efficiency.
6. Differences between burners of the same type may be as great as between burners of different types.
7. Kerosene should oxidize completely to obviate soot.
8. Wicks should be trimmed regularly, and the range should be cleaned and wiped free from all oil seepage to prevent objectionable smoke and odors.

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9

Refrigeration

REFRIGERATION DATES BACK to very early times, if it is defined as the cooling of food below the temperature of the surrounding atmosphere for the purpose of preserving the food. When primitive man had killed, he probably ate the fresh meat to repletion, then discarded the remains of his feast and, when hungry, killed again. Such a manner of living was possible only when the number of people in a given area was comparatively small and when the supply of game was abundant. With an increase in the inhabitants of a land, the natural food supply became less and man was forced to find some method of storing any temporary surplus. The first refrigerators were doubtless caves or cold springs, and they are sometimes used today. Where natural caverns do not exist, artificial caves are dug or a springhouse for the storage of milk and butter is built over a spring, a running brook, or a well, where comparatively cool temperatures may be obtained.

History

Foods are cooled not only for preservation purposes but also to develop flavor. In warmer countries some means of cooling water and wines was an early need. Records tell how the ancient Egyptians filled porous jars with water, covered them with reeds, and left them on the flat house-tops during the night. The breezes caused some of the water to evaporate, and this evaporation cooled the rest sufficiently for use. Sometimes slaves fanned the water to hasten the action. These same methods are used today in parts of India.

Rules for religious ceremonies performed during the filling and emptying of ice cellars have been found in a collection of ancient Chinese lyrics, dating from before 1000 B.C. Alexander the Great had trenches filled with snow in which to cool wines for his soldiers. And Nero, the Roman Emperor, forced innumerable slaves to bring ice and snow from the higher mountains in Italy. This snow, placed in pits insulated with sod and straw, was used in cooling wines, fruits, and fish for his elaborate banquets.

Later, ice was harvested from rivers and ponds in the winter, and stored for summer use. In the seventeenth century such ice was sold

in France under governmental control but this proved unsuccessful, the licensed distributors charging such exorbitant prices that people refused to buy. Ice harvesting is still a common practice in many sections of the world.

The story of Lord Bacon is familiar. He was so interested in the possibilities of food preservation by cold that he stopped his carriage in a suburb of London one winter evening, purchased a chicken at a nearby farmhouse, and stuffed it full of snow. His experiment unfortunately proved fatal to himself for he developed pneumonia and died. His interest in the result remained keen until the end, for just before his death he is said to have asked a servant if the fowl still kept.

Water and milk ices were used in China as early as the thirteenth century, and at about the same time in the Near East. Sir Walter Scott tells how Saladin, the Mohammedan, sent a frozen sherbet to King Richard of England, when Richard contracted fever during his crusade. But from the time Dolly Madison first served ice cream in the White House until the present day, frozen desserts have been considered typically American. People of no other country have made frozen creams and ices of such satisfying texture and of such a variety of flavors.

The first home delivery of ice in America was in 1802. This necessitated the building of a form of ice chest, a heavy wooden box large enough to hold both ice and food, the forerunner of the refrigerator of the present day.

Attempts to bring about refrigeration by mechanical means were made as early as the middle of the eighteenth century. In 1755 Dr. Cullen produced cold by evaporating water under a vacuum. A hundred years later (1850) an air compression system was developed by Dr. Gorrie of Florida. During the Civil War an ammonia absorption machine invented by Carré was used in the South to make the first artificial ice, and a few years later ammonia was also used in a compression type of system both by Linde in Germany and David Boyle in America. It was not until after 1890, however, that artificial ice production and mechanical refrigeration made rapid progress. In that year an unusually mild winter caused a severe ice famine the following summer. As a result ice making became an established industry. Today more than 30,000,000 tons of artificial ice are manufactured yearly in America alone three times the amount cut from lakes and rivers. In addition mechanical refrigerators are in use.

And yet one-fourth to one-half of all families living in the United States has no adequate means of food preservation.

Physical principles

The theory of refrigeration is based upon certain fundamental laws of heat, a form of energy generated by the vibration of molecules.

Heat transfer

Heat always passes from the warmer to the cooler body and does so in one of three ways, by radiation, by conduction, or by convection. Convection currents bring about cooling in a refrigerator to a greater extent than other methods of heat transfer; warmth in food and refrigerator walls is carried by means of these currents to the compartment containing the refrigerant.

Temperature versus heat capacity

Heat is a form of energy. Its presence in a body is accompanied by a sensation of warmth. Two bodies of vastly different sizes may have the same temperature, but the larger one will contain more heat. Temperature is measured by a thermometer; heat, in British thermal units or calories. A British thermal unit, usually written Btu, is the amount of heat needed to raise the temperature of 1 pound of pure water 1° F., usually at the point of maximum density, 39.1° F. (4° C.). Water is taken as the standard because of its large heat capacity.

Specific heat

Refrigeration also involves a knowledge of specific heat. The specific heat of any substance is its capacity to absorb or retain heat compared to the capacity of an equal weight of water. In constructing the refrigerator cabinet it is necessary to know the specific heat of the materials used, and also the specific heat of the foods to be stored in the refrigerator, in order to determine the size of ice space or cooling unit to build to absorb the heat from the various substances and maintain the desired temperature.

Specific Heat of Some Foods Commonly Kept in the Refrigerator

(Fresh) Beef	0.75	Chicken	0.80	Fish	0.80
Berries	0.91	Celery	0.96	Milk	0.90
Butter	0.60	Cream	0.68	Watermelon	0.92
Cheese	0.64	Eggs	0.76		

It is to be noted that the specific heat of those foods containing a higher percentage of water approaches more nearly the specific heat of water, 1.0. Since the specific heat of milk is 0.90, it would require 0.9 Btu to raise the temperature of 1 pound of milk 1° F.

Latent heat

Latent heat, which accompanies a change of state, from a solid to a liquid or from a liquid to a gas, cannot be measured by a thermometer. It is the heat needed to bring about the change and is used in separating the molecules of the substance. Molecules in a solid are closer together than are the molecules in a liquid, and liquid molecules in turn are more closely packed than the molecules of a gas. It is evident that energy is required to separate these molecules in changing from one state to another. The heat required to change a solid to a liquid is known as latent heat of fusion. The latent heat of fusion of ice is 144 Btu; that is, it takes 144 Btu to melt 1 pound of ice at 32° F. The latent heat of vaporization of water at 212° F. (100° C.) is 971.7 Btu. The latent heat necessary to melt ice in a refrigerator is absorbed from the area of the refrigerator and makes it cool. Similarly, in the mechanical refrigerator, when the liquid refrigerant changes to a gas it absorbs heat from the food box. Conversely, when the gas is again liquefied it gives off an amount of heat equal to what it had absorbed, but this process is carried on outside the refrigerator cabinet. To condense or liquefy a gas, a correct combination of temperature and pressure is essential.

Critical temperature and pressure

The point at which the density of a liquid and the density of the vapor above the liquid are equal is known as the critical temperature. Regardless of the pressure, no substance can exist as a liquid above its critical temperature. The pressure of the saturated vapor at the critical temperature is called the critical pressure. To be practical for use in household refrigerators, a refrigerant in the form of a vapor must be cooled sufficiently to be liquefied without excessive pressure.

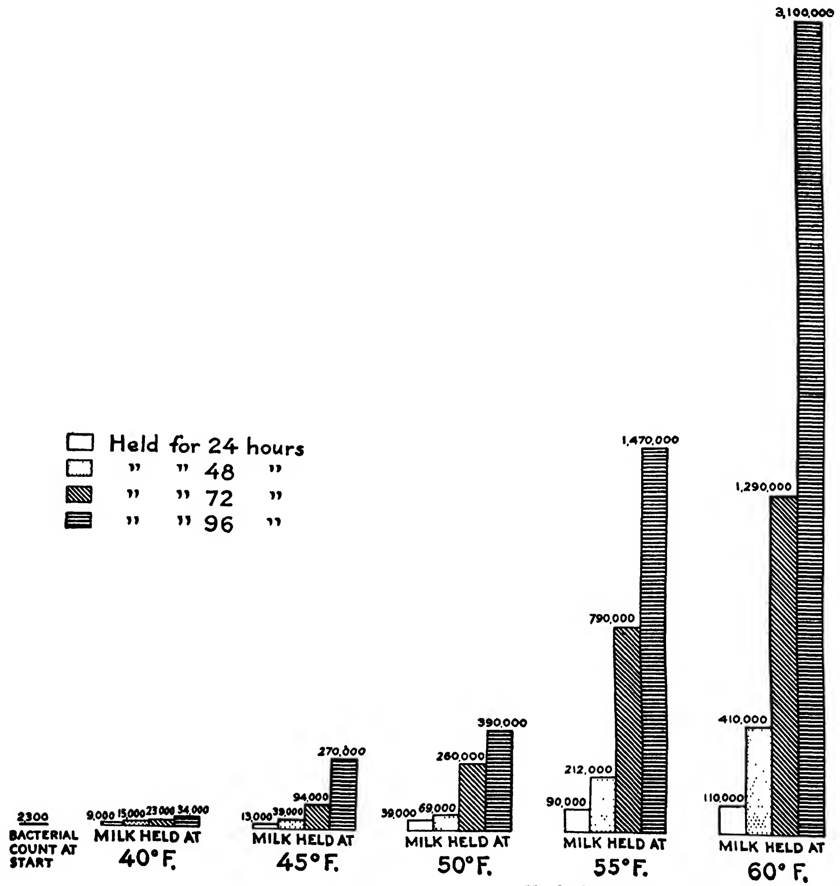
Change in boiling point

Water boils and changes from a liquid to a vapor at 212° F. at sea level. In changing, work has to be done against an atmospheric pressure of 14.7 pounds per square inch of exposed surface. At higher altitudes the atmospheric pressure is less and so water boils more easily and, therefore, at a lower temperature—a 1° decrease for every

thousand feet rise in altitude. If water is evaporated under a partial vacuum, it will evaporate at a temperature considerably less than 212° F., depending upon the degree of vacuum present. As has been noted, Dr. Cullen employed this principle in a mechanical machine for producing cold as early as 1755. It was successful enough to be used in cooling wines in Paris restaurants. The same principle is utilized in electric and gas refrigerators of the present day.

Need for refrigeration

Our early ancestors recognized the need of preserving food from spoilage, although the cause of the spoilage was unknown. It is now



U. S. Bureau of Home Economics

Fig. 108. Increase in bacteria in milk when held in refrigerators at different temperatures.

known to be due to the presence of tiny plant microorganisms—molds, yeasts, and bacteria. Molds and yeasts may be seen when they have increased sufficiently in number, but bacteria, which cause the most harm, are always microscopic in size. As the organisms grow and multiply they cause certain chemical changes in the food, which alter the flavor and may be detrimental to health. Experiments have proved that, in addition to the presence of suitable food, these plants require a certain amount of moisture and warmth for growth. Ordinary atmosperic conditions in most sections of the world supply the necessary moisture and warmth for at least a part of each year. Tests show that bacteria multiply rapidly at high temperatures, and 50° F. has been chosen as a convenient, economical maximum temperature to be permitted in the refrigerator in the present development of household equipment. There is no magic in the 50°, however, no evidence that 50° is a critical temperature in the preservation of foods, and certain foods need an even lower temperature for preservation and safety. (Fig. 108.)

Alternate freezing and melting of foods are also to be avoided. Vegetables, fruits, and meats are made up of many tiny cells, containing a watery fluid surrounded by a fibrous wall of cellulose. When these foods freeze under ordinary conditions the liquid in the cells expands and tends to rupture the surrounding walls. Upon their melting, the texture is no longer firm but mushy and undesirable. Foods should, therefore, be kept cold but at a temperature above freezing; in other words, a temperature below 50° F. but above 32° F. should be maintained for economical food preservation. Records of the U. S. Weather Bureau show that in the United States there is an average of only 19 days in the year when atmospheric temperatures fall within this range. In Iowa the average is only 15 days. The need for some method of artificial refrigeration is at once apparent.

Cooling process

A refrigerator is the appliance used to preserve food by cooling, and it is important to know how this cooling is brought about. As has been said, heat always flows from a warm to a cool body. When food at room temperature is placed within the ice refrigerator, for example, the warmth it contains passes into the surrounding air which circulates toward the ice and then across the surface, melting the cake. During the meltage, heat is absorbed (latent heat of fusion) and the air cooled. The cold air drops toward the bottom of the cabinet, and, as it becomes warmed, again rises and passes over the ice. In cold air

the molecules are packed more closely together than in warm air; hence, a given volume of cold air contains more molecules than an equal volume of warm and is heavy, whereas the warm air is light. When the refrigerator is properly constucted, these convection currents form a continuous cycle. In the mechanical refrigerator the process is similar. When the warm air circulates over the unit the refrigerant is vaporized, absorbing heat from the food chamber.

The circulating air gathers moisture from the foods over which it passes and the odors are dissolved in the moisture. Cold air can hold less moisture than warm air; therefore, as the warm air passes over the ice and is cooled, some of the moisture is deposited with the film of meltage from the ice, and the odors are carried away through the drain pipe. In the mechanical refrigerator, moisture is deposited as frost on the unit.

Anything that hinders efficient circulation retards refrigeration. Ice should not be covered; wrapping the ice in newspapers or burlap is a misguided effort in economy. It is the melting of the ice that cools the food. Foods should not be placed on the ice or even in the ice compartment, and storage containers in the food chamber should be separated sufficiently to allow the air to move freely.

Construction of refrigerators

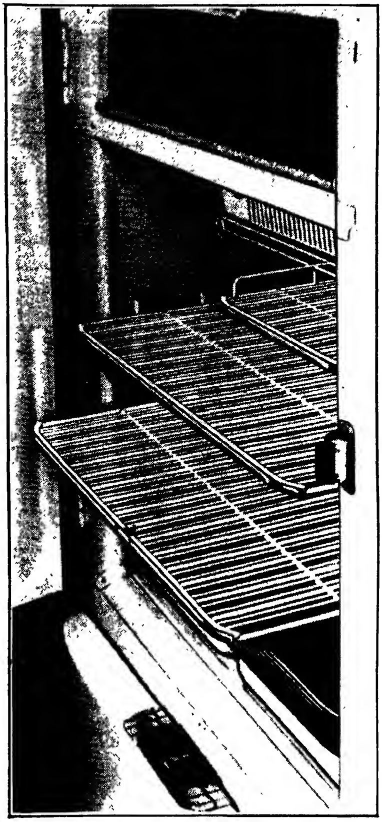
Refrigerator cabinets are made of wood or of steel. If wood is to be used it must be very well-seasoned hard wood; otherwise it tends to shrink in dry weather and to swell during periods of excessive humidity. Ash, spruce, fir, and oak are good. Joints should be fastened together with tenons, or be braced to maintain rigidity of shape and prevent air leakage. The outside sheathing should be of simple design to be easily cleaned, and should be painted or varnished to preserve the wood. It is well to repaint or revarnish the surface at regular intervals. Modern wood cabinets are frequently covered with a coating of synthetic enamel (also called organic enamel) on sheet steel, which is very resistant to dents or chipping. Sometimes only the frame is of wood with metal panels inside and out.

Steel frames are more rigid than wood, and joints may be welded securely, but steel is a much better conductor of heat and requires added insulation in the walls. If the frame is of steel the outside finish may be porçelain enamel or synthetic enamel baked on at a high temperature. Before the finish is applied the metal is "bonderized."

The top of the refrigerator cabinet may be curved or flat. Tops on the postwar models are only slightly rounded, in case the home-

maker may occasionally wish to use the top as a shelf when she removes food from the refrigerator or puts it in.

Lining. The most satisfactory lining is two or three coats of vitreous enamel. With this enamel for a lining, the steel or iron frame may be made in one piece, and joints and seams, which tend to cause air or moisture leakage, are avoided. Some refrigerators have an interior finish of synthetic enamel, or the walls may be finished in the synthetic enamel and the bottom, which receives more of the wear, in porcelain enamel. In other models the porcelain enamel of the bottom is extended several inches up each side wall. Whatever finish is used, it should be stainproof and impervious to moisture and should not crack, chip, or peel. The lining should have rounded corners and unions to simplify cleaning, and the bottom should be slightly depressed to catch liquids accidentally spilled. Shelf supports should be integral with the lining and not separate knobs or glides.

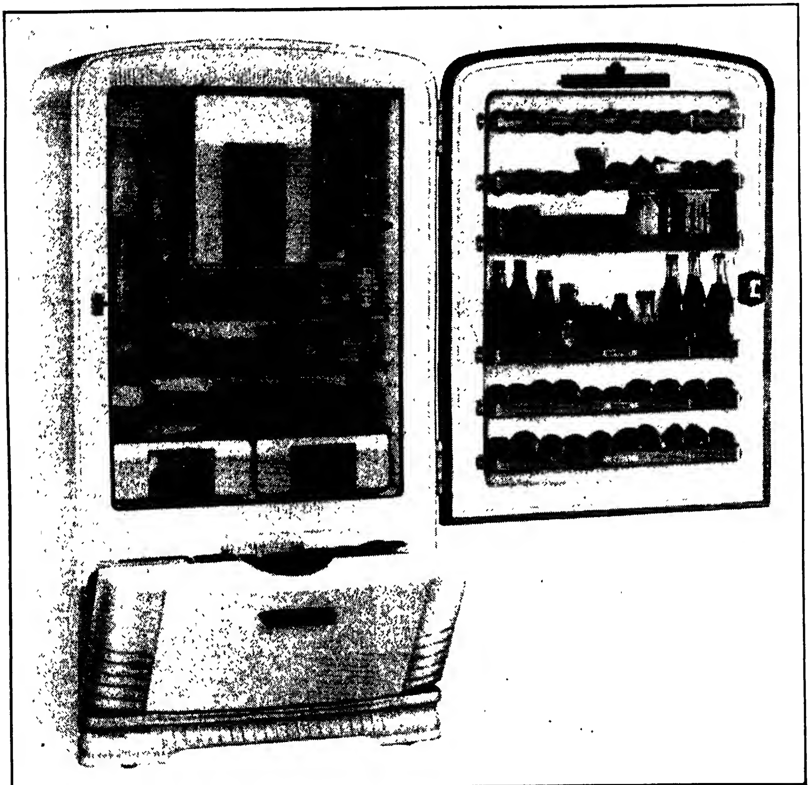


Servel Gas Refrigerator

FIG. 109. Shelves with white plastic coating.

Shelves. Shelves are made of corrosion-resistant metal rods or bars, near enough together to hold small storage dishes without likelihood of their tipping, but spaced widely enough apart for efficient air circulation. The gas refrigerator is featuring shelves with a white plastic coating. (Fig. 109.) This coating is applied to the zinc-plated steel shelf and offers improved appearance and sanitation. The plastic finish is acid and grease resistant, does not dent, chip, or flake off, will not soften or discolor, is easily cleaned in warm soapy water, and is not damaged by the common abrasives. Glass shelves have been used in a new electric refrigerator. The glass is ribbed, and the front edge of the shelf is trimmed and protected with an aluminum molding.

Shelves should be sliding, with a positive stop. A rear guard rail prevents dishes from falling off at the back when the shelf is pulled forward. At least one manufacturer places guard rails on all sides of certain shelves, making a "basket" shelf designed primarily for storage



Crosley Corp.

FIG. 110. Shelves on the door provide additional storage space.

of small containers. Shelves adjustable to more than one level increase the flexibility of food-chamber space and arrangement. Similar advantages are obtained from a divided shelf, part of which may be removed when larger space is needed for storage of oversize articles. (Fig. 120.) Narrow shelves recessed in the regular door or attached to an inner food-chamber door afford storage for many small items not easily accommodated on the inner shelves. (Fig. 110.)

Drain pipe. The drain pipe in the ice refrigerator is preferably of brass or copper, plated on the outside with nickel or chromium. It is

better, however, to leave the inside surface unplated, since slime will not cling to copper. Slime is formed from precipitation of the volatile food substances picked up by the circulating air, and not from the melting ice. Artificial ice is made from purified water, and impurities in natural water tend to freeze out as the ice solidifies. The drain should have a trap to prevent undesirable odors or insects from finding an entrance into the refrigerator by this path and to lessen heat leakage. The cup in the trap should be of copper. The pipe should be held securely in place but at the same time be removable for cleaning. Connection to the sewer is a convenience, although it may increase the cleaning problem.

Insulation. The efficiency of the refrigerator depends largely upon the kind and amount of insulation that is between the outer wall and the lining. Insulation is a material that is a poor conductor of heat. Experiments have proved that 80 to 90 per cent of the heat that gets into a refrigerator comes through the walls, making necessary more frequent replenishing of ice or causing the mechanical unit to run a larger percentage of the time. The rest, insignificant by comparison, comes from opening the door and from the warmth of the food placed within the cabinet. Good insulation, therefore, is a true economy. Refrigerators are rated by the thickness of the insulation, the cabinets of highest class having at least 3 inches. Many of them have 4 inches. An efficient insulating material must be heat resistant and moisture resistant, non-destructible, and odorless. Moisture is a good conductor of heat. The insulation must also maintain its position between the walls and not settle or sag, leaving air pockets to conduct heat. So-called dead-air spaces or layers of paper are not satisfactory insulators. The dead-air spaces usually contain some moving air caused by the difference in temperature between the inner and outer walls, and moisture is deposited when the air cools. Paper does not stay in place.

Glass and rock wools and Fiberglas are the most widely used insulating materials for modern refrigerators. They are usually made into slabs or matted into blankets. When the cabinet is of steel, a layer of wallboard ½ inch thick is frequently placed next to the outer wall to decrease heat penetration. As a further precaution against any possibility of moisture being absorbed, the material may be sealed into the walls with an odorless asphalt mixture such as hydrolene.

Doors. Doors may be regarded as a part of the wall and should have the same insulation as the walls. Prewar cabinets frequently

had wedge-shaped doors, but the newer refrigerators have flush door construction that allows the shelves to extend to the front of the food chamber. The opening, both on door and on cabinet, is lined with a breaker strip of wood or plastic or other composition material to prevent heat leakage that would occur if the metal lining came into direct contact with the outer frame. Screws should be eliminated as far as possible. The entire door lining is sometimes of plastic. The outer edge of the door is furnished with a rubber gasket—frequently of synthetic rubber—to make the door fit more closely. The latches and hinges should be of first-class construction, to hold the door securely. It is convenient to have the latch not require hand manipulation, but hold when the door is pushed shut with the arm or knee, in case the hands are filled with supplies that have been removed from the cabinet. The hardware should be finished in chromium to be rustproof and easy to care for.

Refrigerators should sit flat on the floor or be "broom high" to facilitate cleaning beneath them.

Size

The size of cabinet needed depends upon the number in the family, the amount of entertaining done, and the necessity of keeping extra supplies on hand. It is estimated that a family of two eating all meals at home will need at least a 6-cubic-foot refrigerator. An extra cubic foot will be required for each two additional members. Some authorities suggest adding 2 cubic feet for storing food for guests. Another method for calculating size is to allow 1 cubic foot per room in the house.

Refrigerators may be purchased in a number of over-all dimensions. Widths vary from $23\frac{7}{8}$ inches to 34 inches, depths from $23\frac{1}{4}$ inches to $29\frac{3}{4}$ inches, heights from $53\frac{1}{32}$ to $63\frac{15}{16}$ inches. Measurements are accurate to within $\frac{1}{64}$ inch; e.g., refrigerators made by one manufacturer have the following dimensions: widths $30\frac{3}{8}$, $30\frac{15}{16}$, and $30\frac{3}{4}$ inches; depths $28\frac{1}{4}$, $25\frac{5}{16}$, and $28\frac{31}{64}$ inches; heights 61, 60, and $60\frac{1}{16}$ inches, respectively.

Ice refrigerators

The modern ice refrigerator is similar to the mechanical types in construction, size, and finish. It is usually a top-icer with two vertical doors, one for the ice chamber and one for the food compartment, or it may have a single door with or without a second inside door for the ice chamber. The lining of the ice compartment is usually of

galvanized iron. The ice rack may be of the same material or of stainless steel. Refrigerators of 5- to 6-cubic-foot content have a shelf area of about 10 square feet and an ice capacity of 75 to 100 pounds, with a reicing capacity of approximately 50 pounds. Reicing is necessary on an average of every 4 or 5 days.

In the new models the air does not usually circulate over all the ice as in the older types but simply across the bottom surface, which covers practically the entire width of the cabinet. Owing to the way in which the ice compartment is constructed, the ice melts horizontally, and the air is cooled adequately and maintained at a fairly constant temperature so long as a thin sheet of ice covers the opening into the food chamber. Theoretically this condition is true, but actual tests show that the ice melts away at the sides to some extent so that air tends to circulate over the cake toward the end of the period before reicing is necessary. Chipping the ice that remains on the rack before placing the new cake slows up this process.

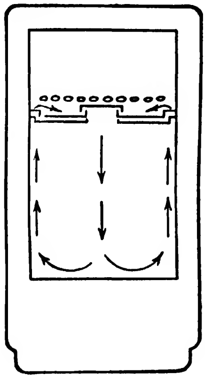


FIG. 111. Method of air circulation in modern ice refrigerator.

The method of air circulation in this type of refrigerator is shown diagrammatically in Fig. 111. The air drops through an opening in the center of the rack, passes across the bottom of the food compartment to the sides, and again rises to the lower surface of the ice.

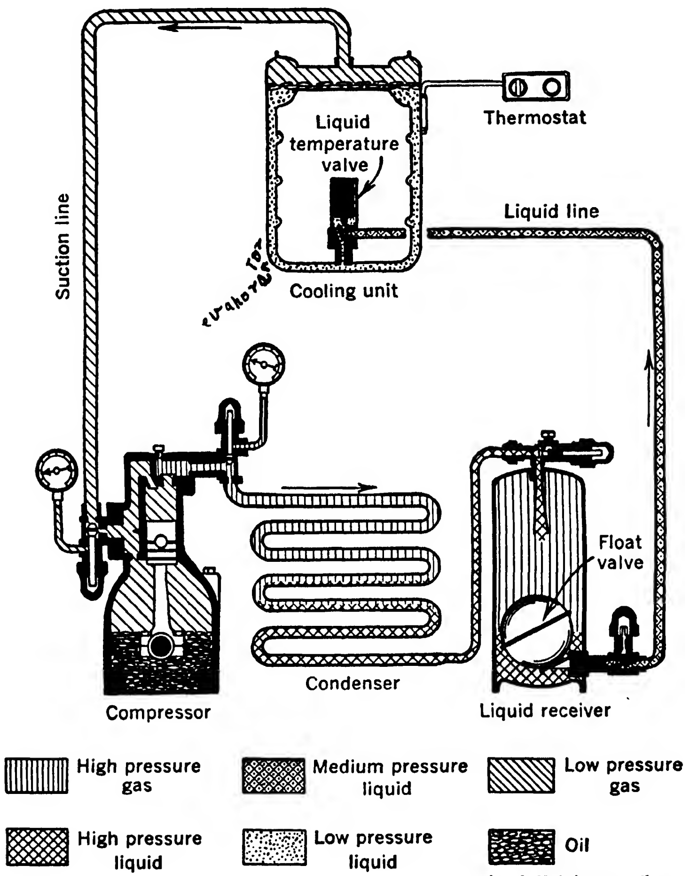
In one postwar model, the ice chamber is surrounded by a system of flues through which the air circulates. The air passes over sections of five sides of the cake. If this area is greatly reduced in size, the temperature will tend to rise. Reicing should be frequent enough to maintain as nearly as possible the initial area of ice surface exposed to the circulating air.

Ice cubes may be cut from the cake of ice by the aid of a special device, which is filled with warm water and placed on top of the cake. The warmth of the water is conducted to a series of baffles that melt into the ice to form cubes. A chipping tool removes the cubes from the cake and at the same time holds them for transportation to the point of use.

MECHANICAL REFRIGERATORS

Mechanical refrigerators may be operated by electricity, gas, or kerosene, the largest number being electric. In all types, refrigera-

tion is based primarily upon the two fundamental physical laws previously referred to: (1) when a liquid changes to a vapor or gas, heat is absorbed; and (2) when the vapor is again liquefied it gives off the heat it has taken up. Electricity or gas or oil supplies the energy



Nash-Kelvinator Corp.

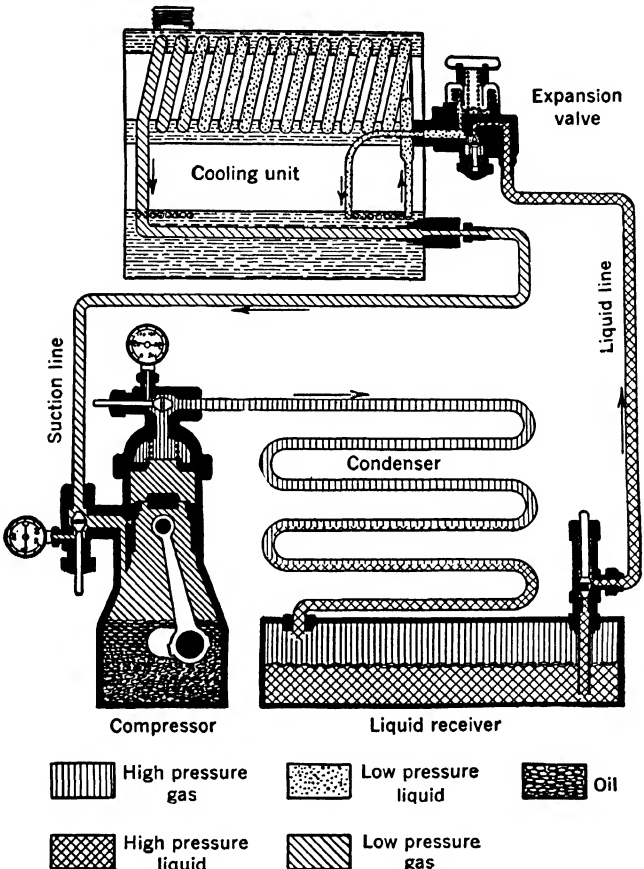
FIG. 112. Compression system, flooded type.

that starts the cycle. In the gas or oil refrigerator Dalton's law of partial pressures of gases is also utilized.

The discovery that certain substances would undergo these changes of state was first made by Faraday in 1824. He found that, if he compressed ammonia vapor and then cooled the vapor, he could obtain liquid ammonia. When he removed the pressure, the liquid boiled and changed back to a vapor, absorbing heat in the process.

COMPRESSION SYSTEM

These three steps take place in electric refrigerators in a more or less continuous and controlled cycle. The system is closed so that



Nash-Kelvinator Corp.

FIG. 113. Compression system, dry type with expansion valve.

the refrigerating substance may be used repeatedly. In household refrigerators of this type, sulphur dioxide or one of the "Freon" compounds is the refrigerant. Since the vapor is compressed by means of a motor, the system is called the compression system to distinguish it from the absorption system, which uses gas or kerosene oil instead of electricity. The size of the motor varies usually from 1/5 to 1/8 horsepower. Figure 112 shows in diagrammatic form the essential

parts of the compression system: (1) the reciprocating type compressor, (2) the condenser, and (3) the cooling unit or evaporator. In addition, there are the motor to drive the piston in the compression cylinder and the thermostat to control the off and on periods of the motor according to the temperature of the food chamber.

The cooling unit is located within the food chamber. A thermostat determines the temperature to be maintained. The thermostat bulb is either attached to the cooling unit or placed close to it. It usually contains a volatile liquid which changes to a gas as the temperature of the evaporator coils rises. The variation in pressure opens or closes the contact points of the circuit and causes the motor to stop or start operating.

The compressor draws the gaseous refrigerant from the evaporator, compresses it, and discharges it into the condenser coils, where it is changed back into a liquid. The condenser may be cooled by direct radiation or by means of forced air circulation from a fan. The coils are usually supplied with fins to increase the surface area exposed. The condensed refrigerant passes into the evaporator either through an expansion or a float valve. (Figs. 112 and 113.)

Dry and flooded systems

The construction in which the expansion valve is used is known as the "dry" system, because the refrigerant is sprayed through the valve into the evaporator in a semiliquid form. The valve is located on the outside of the evaporator.

In the "flooded" system, the amount of refrigerant supplied to the evaporator is regulated by the depth of liquid in the receiver and the float valve. The float valve may be located in the liquid receiver or may be within the cooling unit itself. Some flooded systems have no float; instead a liquid tube of very small diameter connects the condenser coils to the cooling unit. When the pressure in the condenser has increased sufficiently, it forces the refrigerant through this tube.

High and low side

The refrigeration system between the valve where the vapor enters the compression cylinder and the float or expansion valve is known as the "high side" because of the high pressure maintained; the remainder of the system is known as the "low side." In this part the pressure is low. To maintain this difference in pressure so that there

will be correct liquid flow from the high to the low side, the system of valves is essential.

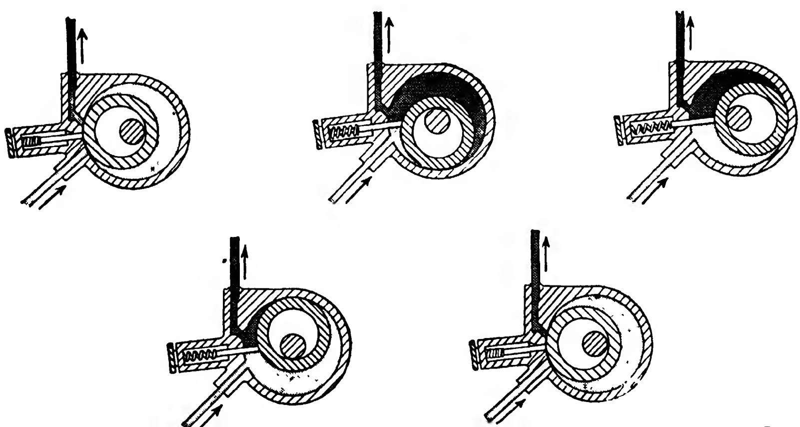
Types of units

The unit of the compression system may be hermetically sealed or may be the conventional type. In the sealed construction, the motor and compressor are within the same housing and the whole system is so connected that there is almost no possibility of leakage. Additional lubrication is also eliminated. The majority of present-day models are of this type.

In the conventional type, the motor and compressor are separate and the compressor shaft is driven by an exposed belt connected to the motor. It is necessary to surround this shaft by a packing, since there is a tendency for the refrigerant to leak out around the piston shaft when the pressure inside the cylinder is greater than atmospheric, and for air, probably containing moisture, to leak in when the atmospheric pressure exceeds that in the cylinder. The packing must be flexible, and it is sometimes difficult to make it at the same time sufficiently tight to prevent leaks. The conventional system does, however, lend itself to easy servicing in the home. If the hermetically sealed unit gets out of order, it must be returned as a whole to the factory.

Rotary compressor

Some electric refrigerators use a rotary compressor instead of the reciprocating type. Figure 114 shows the five positions of the



Borg-Warner Corp.

Fig. 114. Rollator cycle.

Rollator cycle. The refrigerant enters the chamber at the bottom, is compressed by the rotating movement of the crankshaft, and is discharged through the vertical pipe. Note that the movable blade is always in contact with the sleeve and separates the chamber into two sections. Intake and compression take place simultaneously and not in separate movements as in the reciprocating type of compressor. In other respects the system is similar to the conventional.

Temperature of unit

Just as it is necessary for a radiator to be hotter than the room, so it is essential for effective cooling that the evaporator be colder than the atmosphere in the cabinet. The thermostat is usually set at the factory where the refrigerator is manufactured for the evaporator to maintain a maximum temperature of 28° F., and a minimum of 5° F. to 10° F. At this setting the motor operates from 15 to 30 per cent of the time, or from 3 to 7 hours out of the 24. Lower temperatures may be obtained by setting a manually controlled dial. In some units additional coils soldered to the bottom of a shelf in the evaporator cause a concentration of refrigerant at that section and automatically permit rapid freezing without excessive cooling of the food compartment. In such an arrangement the shelf is permanently attached to the evaporator sleeve. This construction frequently interferes with the flexible storage of frozen foods and should be avoided if possible.

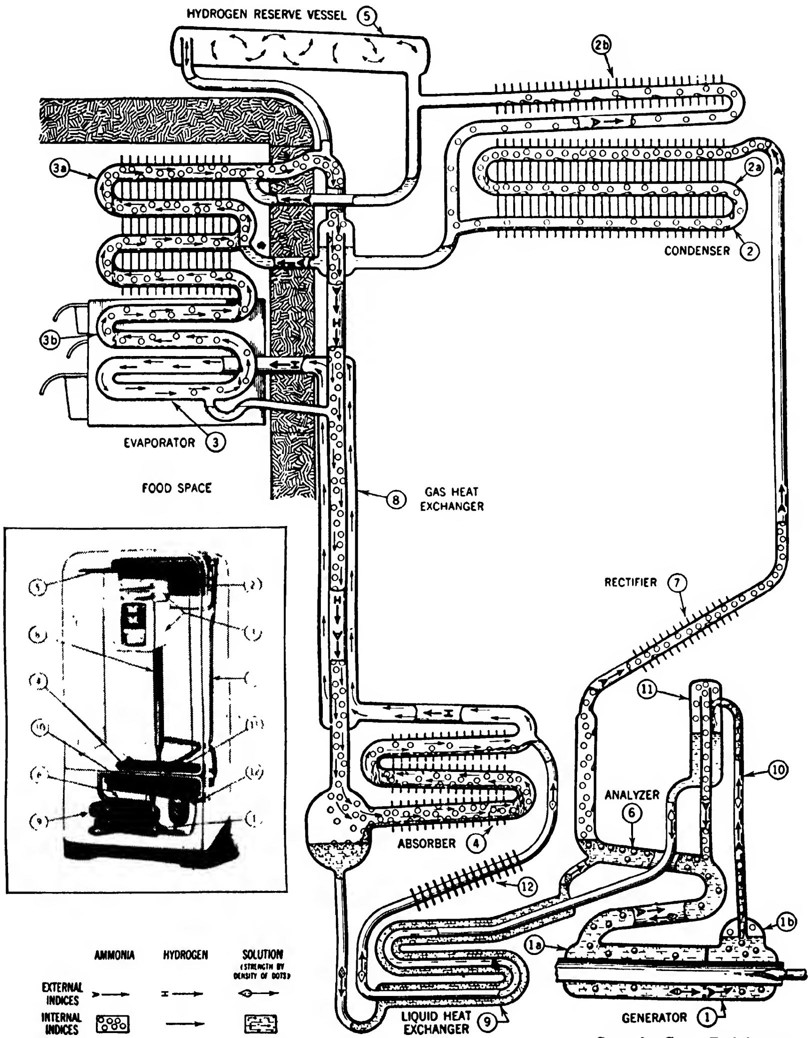
Cold-wall refrigerator

In a number of electric refrigerators the evaporator space is separated from the food chamber by a shelf, edged with a rubber gasket that makes close contact with the door lining and so prevents circulation of air into the lower chamber. Additional evaporator coils are between the walls surrounding the food compartment, and these maintain an approximately constant temperature within the enclosed space. The evaporator provides storage for ice-cube trays, frozen foods, and meat. Other foods are stored in the food chamber as usual. Since a minimum of air circulates in this section, with consequent slight removal of moisture, an atmosphere of comparatively high humidity prevails and foods are maintained in a satisfactory condition during short periods of storage without the necessity of covering them. Even in these refrigerators, hydrator drawers are supplied for storage of succulent fruits and vegetables.

The dual temperature refrigerators will be discussed in the section on home freezers.

Absorption system

In the absorption system, where gas or oil is used to help bring about the necessary changes in the refrigeration cycle, an additional

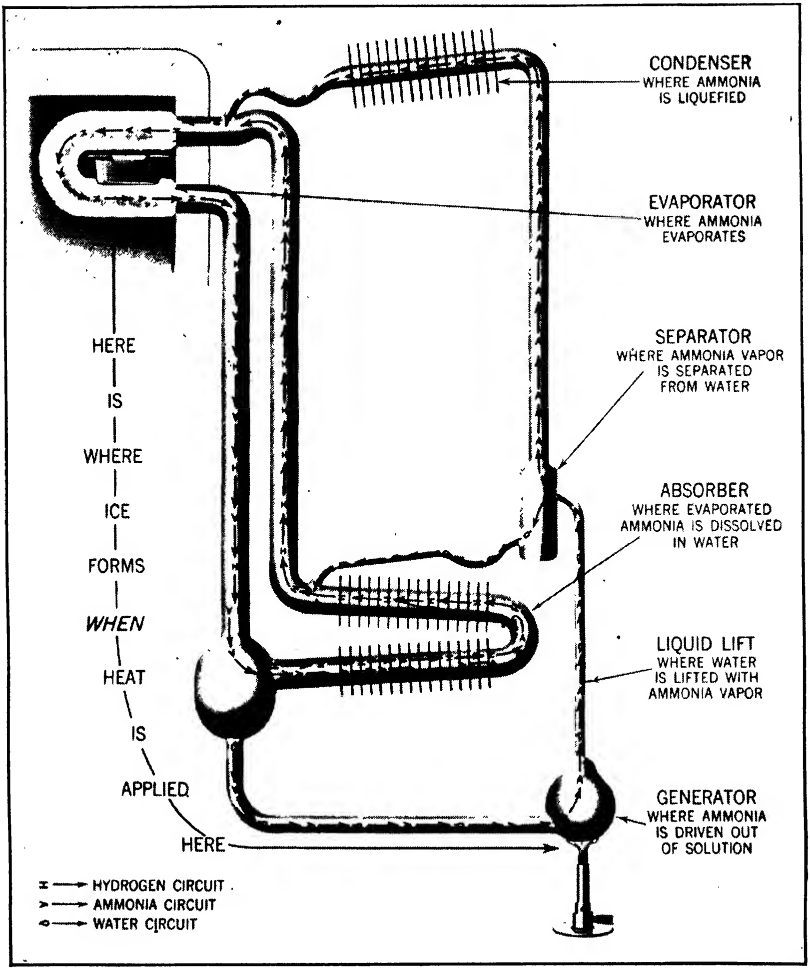


Servel Gas Refrigerator

Fig. 115. Absorption system.

part is needed, the absorber, and this gives the name to the system. Ammonia is the refrigerant commonly used. The action depends upon the ease with which ammonia gas dissolves in cold water, and the

fact that the combination is at best an unstable one, easily broken down by heat. The solution is slightly stronger than ordinary household ammonia. The process is continuous, not intermittent as in the compression system. There are no valves or moving parts.



Servel Gas Refrigerator

FIG. 116. Simplified diagram of absorption system.

Figure 115 shows the complete refrigerating mechanism. It is made up of a series of steel chambers connected by steel tubes, all welded together. The essential parts are generator, condenser, evapo-

rator, and absorber. A simplified diagram of the system is given in Fig. 116.

The liquefied ammonia passes from the condenser into the evaporator. To hasten the change into a vapor, the evaporator contains an atmosphere of hydrogen, the lightest gas, which reduces the pressure a predetermined amount. The total pressure in the condenser and evaporator are the same. According to Dalton's law of partial pressure of gases, the total pressure of a mixture of gases is equal to the sum of the partial pressures of each gas. The partial pressure of the ammonia in the evaporator is, therefore, less than its total pressure by an amount equal to the pressure exerted by the hydrogen. Evaporation of the ammonia at this reduced pressure is consequently rapid. This change of liquid ammonia to a vapor is accompanied by absorption of heat, which is removed from the food cabinet.

Absorber

The heavy mixture of ammonia and hydrogen vapor passes from the evaporator into the absorber through the center of the gas heat exchanger. (Fig. 115.) In the absorber the ammonia vapor dissolves in water, forming ammonium hydroxide, and the hydrogen, which is nearly insoluble in the water, passes upward through the outside chamber of the gas heat exchanger to the evaporator again. The difference in weights of the combined ammonia and hydrogen vapors and the hydrogen gas alone makes possible the cycle of hydrogen flow.

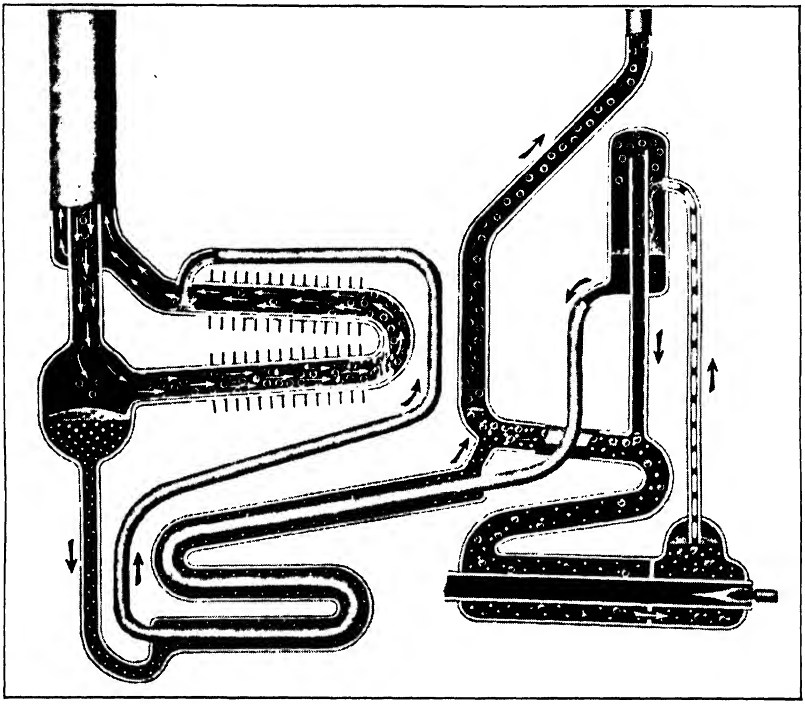
Generator and condenser

The ammonium hydroxide flows from the absorber through the analyzer to the generator. Here heat from a gas or oil flame starts the separation of the hydroxide into ammonia and water. A percolator form of siphon raises the ammonia, water vapor, and some unchanged weak hydroxide to an upper container where the separation continues. (Fig. 117.) The water flows by gravity back into the absorber and the ammonia is driven into the air-cooled condenser where it again becomes a liquid under pressure, at reduced temperature. Some ammonia passes from the analyzer directly to the condenser by way of the rectifier, which removes any residue of moisture. The direction of flow of the different fluids is controlled by liquid traps, which are maintained automatically.

The total pressure of the system is constant and sufficiently high to permit the ammonia to condense under ordinary temperature condi-

tions. The pressure of the ammonia itself varies, but the hydrogen equalizes any differences that occur.

When the ambient temperature is high, as frequently happens during the summer, the ammonia vapor may condense with difficulty. Condensation will take place readily, however, if pressure is increased.



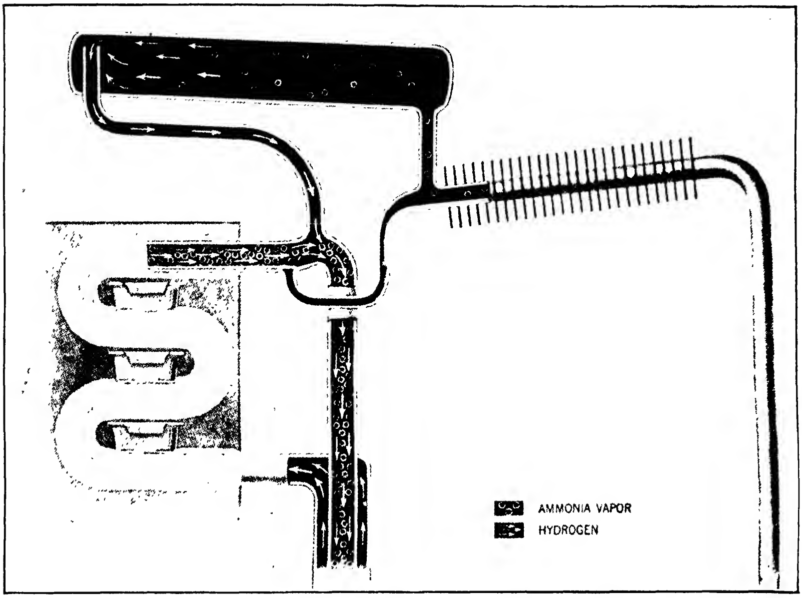
Servel Gas Refrigerator

FIG. 117. The absorber and generator section of the system. The water flows back into the absorber.

Additional pressure is introduced into the system by placing a hydrogen reserve vessel between the condenser and the evaporator. Under normal temperature conditions the hydrogen remains in the vessel. If the ammonia fails to condense, it passes into this reserve vessel and forces some of the hydrogen out. Pressure in the system is increased by the presence of the additional ammonia gas, and condensation takes place. The displaced hydrogen meanwhile enters the evaporator and counterbalances the increased condenser pressure so that the partial pressure of the ammonia in the evaporator remains the same. (Fig. 118.) As Fig. 116 indicates, the operation depends for

the most part on the force of gravity, with one chamber placed below another and the pipes sloped to allow easy flow of vapor or liquid.

The ammonia vapor will unite more readily with the water in the absorber if the water is cool. Heat, as has been noted, tends to separate the two. Precooling of the water is accomplished by running the pipe carrying the water from the separation chamber inside the



Servel Gas Refrigerator

FIG. 118. Hydrogen-reserve vessel.

pipe through which the ammonium hydroxide is flowing to the generator. This arrangement is known as the liquid heat exchanger. The absorber is now constructed in the form of a double-finned loop. The fins help to dissipate the heat liberated from the absorption of the ammonia by the water.

When the refrigerator is in operation, three separate cycles take place at the same time within the unit. The ammonia travels in one cycle from the generator to the condenser, to the freezing unit, to the absorber and back to the generator. The hydrogen travels in another cycle from the absorber to the freezing unit and back to the absorber again. The water travels in a third cycle from the generator to the absorber and back to the generator again. All three cycles meet in the absorber.[1]

[1] Installation Manual, Servel, Inc., p. 10.

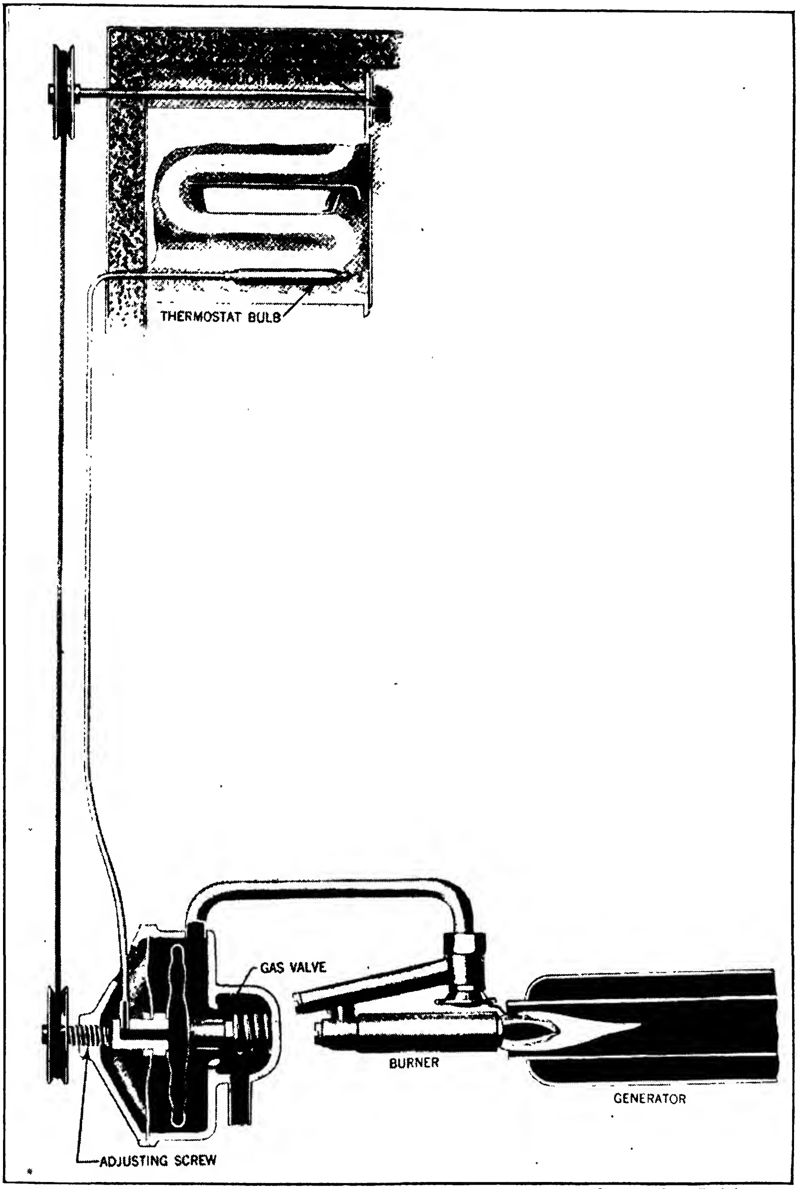
Gas burner

The gas burner of fixed orifice type is fitted with an automatic cutoff, a disk with a finger attachment extending into the flame. This finger cools if the flame is accidentally extinguished and closes the gas valve. When lighting the burner, the disk must be heated before it will open the inlet and permit the gas to flow. The refrigerator may be used with manufactured, natural, or LP gas. Since the Btu heat value of these gases varies, the kind to be used must be specified, that the refrigerator may be furnished with the correct size of orifice and type of burner cap.

Thermostat

The amount of heat generated by the burning gas, i.e., the height of the flame, is regulated by a thermostat, which controls the flow of gas between maximum and minimum limits. The dial on the front baffle of the evaporator has a number of temperature points within the operating range. Figure 119 shows how the thermostatic control functions. The thermostat bulb is the activating mechanism. This bulb, which is fastened to the bottom of the cooling unit, contains a volatile fluid which vaporizes as the temperature rises. The vapor exerts sufficient pressure on the thermostat diaphragm to cause it to expand and push against the stem of the maximum flame gas valve, which opens, allowing additional gas to flow to the burner. When the temperature decreases, the vapor partially condenses, reducing the pressure, so that the flexible diaphragm contracts and partly closes the valve. A smaller flame results. After temperature equilibrium has been established at any given setting on the dial, the diaphragm holds the valve in a fairly constant position to maintain the desired temperature.

When a higher or lower temperature is needed, the distance between the diaphragm and the gas valve stem is changed mechanically by moving the pointer on the dial. The pulley at the end of the temperature control is connected to a second pulley attached to an adjusting screw, which is held in constant contact with the thermostat diaphragm. If the pointer is turned to a colder location on the dial, the screw pushes the thermostat diaphragm nearer to the end of the gas valve stem. The diaphragm will, therefore, have to contract to a greater extent to allow the valve to close, more vapor will have to condense to bring about this contraction, the maximum flame will burn for a longer period, and greater cold will occur in the refrigera-



Servel Gas Refrigerator

FIG. 119. Gas refrigerator thermostat.

tor cabinet. The opposite conditions result when the temperature control is moved to a warmer location.

If the valve is entirely closed, gas will continue to flow to the burner through a by-pass which permits a minimum flame. When the minimum flame is maintained over a period of time, defrosting takes place. Defrosting may be brought about by moving the temperature control to the defrost position, which automatically moves the diaphragm so far from the end of the valve stem that no contact is possible. When defrosting is complete the control may be moved back to an operating position. Some refrigerators have a semiautomatic defrosting system. At the completion of defrosting, operation is resumed by the movement of the diaphragm to a position in contact with the valve stem.

When the temperature in the evaporator rises to 44° F. during defrosting, the thermostat will cause the freezing cycle to start again. This "cut-in" may take place before the unit has completely defrosted, and additional layers of ice will form on the evaporator. Always leave the bottom tray of ice cubes in the evaporator when an automatic thermostat is used for defrosting.

Oil-burning refrigerator

When electricity and gas are not available kerosene may be used to supply the necessary heat for operating the cycle. Ammonia is the refrigerant. The refrigerator is of the absorption type, with a food-storage chamber identical in construction to the one employing gas as the source of heat. The oil tank below the food compartment is fitted with burner, filling hole closed with a cap, and kerosene gauge. The tank holds 3½ or 4½ gallons, depending on the model. The flame should always be extinguished before the tank is refilled.

The tank is pivoted over a pin attached to a lower plate and has a handle on the front face for ease in changing its position beneath the cabinet or for removing it for cleaning.

Two models are available. In one the burner chimney seals automatically when it is pushed beneath the movable asbestos seal ring of the generator flue opening. The top of the glass chimney must make a continuous seal against the asbestos ring or the refrigerator will not operate correctly. In the other model, the seal is made by pushing forward on a seal lever.

The burner assembly is well perforated with holes through which the proper amount of secondary air is drawn when the chimney is

in the sealed position. During operation, the heated air passes through a system of flues which open on the top of the refrigerator at the rear. This top louver assembly can be tilted and lifted off from the cabinet for cleaning. Lint and dust may be drawn into the flues and soot, too, if the burner smokes. The passageways should be inspected occasionally and cleaned when dirty; otherwise the efficiency of the refrigerating system is greatly reduced. A thorough cleaning may even necessitate the removal of the rear panel, so that flues, baffles, and pipe fins may all be reached.

If satisfactory refrigeration is to be obtained it is essential to use a good grade of kerosene, one that is colorless, clear, and free from rust, dirt, and water. The funnel supplied with the refrigerator is fitted with a filter to aid in removing any foreign matter. During ordinary weather, refrigerators of this type consume 15 to 20 gallons of kerosene a month.

Refrigerants

Sulphur dioxide, ammonia, and dichlorodifluoromethane are the refrigerants most widely used in household refrigeration units. The query arises as to why these refrigerants were selected; in other words, what characteristics are desirable in a refrigerant, and how nearly do the ones in use meet the requirements?

A refrigerant should be

1. Non-toxic under all conditions.
2. Non-flammable.
3. Non-explosive by itself or in any mixture with air.
4. Of a characteristic but non-irritating odor.
5. Easily detected in leaks by a simple test.
6. Stable, to avoid disintegration during repeated compression, condensation, and evaporation.

The refrigerant should have

1. A non-corrosive action on metals.
2. A fairly high latent heat.
3. Comparatively low condensing pressure.
4. Evaporating pressure close to atmospheric pressure.
5. Little or no effect on lubricating oils.

None of the refrigerants under discussion, or any of the others that have been used, entirely approaches the ideal.

Sulphur dioxide. Sulphur dioxide is non-flammable and non-explosive. Some authorities also rate it as non-poisonous because it is so suffocating that a person would not remain in an atmosphere containing it, but, according to one investigator, as little as 0.7 per cent by volume of sulphur dioxide in air is toxic in 5 minutes. The irritation such small amounts cause to mucous membranes may be sufficient warning to adults of normal mentality but not to infants or small children, and it may not be possible for the insane or invalids to heed the warning even if they receive it. Fortunately leaks occur very rarely, the quantity of refrigerant in a single unit is small, and the average home is usually fairly well ventilated.

Sulphur dioxide is stable. Leaks are easily located by the fumes that result when ammonium hydroxide is applied to the suspected spot. Sulphur dioxide does not corrode iron, copper, or copper alloys, unless moisture is present. In this case sulphurous acid is formed, and the acid will react with metals. Copper is preferable for unit construction because it has a thermal conductivity seven or eight times that of iron and steel.

The boiling point of sulphur dioxide under atmospheric pressure is 14° F. The boiling point to a large extent determines the operating pressure required in the system. With sulphur dioxide the pressure in the evaporator on the low side of the system is practically atmospheric, 11.82 pound gauge at 5° F. There is, therefore, almost equal pressure on both sides of the stuffing box in the models where the box is used, and less probability of leakage.

Condensing coils cooled by air operate at a pressure 10 to 20 pounds higher than when cooled by water. Air cooling, however, reduces the initial and installation costs and increases the simplicity of the system; it is used by preference whenever possible. Sulphur dioxide has a condensing pressure of 51.75 pound gauge at a condensing temperature of 86° F. This is a comparatively low operating pressure.

If a vapor has a very high latent heat of vaporization, a small quantity will bring about the desired amount of cooling. On the other hand, if only a small quantity of the refrigerant is allowed to circulate, the float or expansion valve must be very sensitive to control the amount that passes. A moderately high latent heat is, therefore, preferable. At 5° F. sulphur dioxide has a latent heat of vaporization of 169.38 Btu per pound. There are 2 to 3 pounds of the refrigerant in the unit.

Sulphur dioxide tends to absorb certain lubricating oils, but there is no chemical reaction between them. Separation is fairly simple be-

cause sulphur dioxide is heavier than the oils. Light-colored oils are less readily absorbed than the darker-colored ones.

Dichlorodifluoromethane. Dichlorodifluoromethane or "Freon 12," as it is commonly called, is the most widely used of a group of refrigerants known as the "Freon"' group. It was developed in the United States as a result of extensive chemical research for a safe practical refrigerant and was introduced in 1931. "Freon 114," dichlorotetrafluoroethane, and "Freon 21," dichloromonofluoromethane are also used in certain systems. The more recently developed "Freon 22" is used in some home freezers.

Dichlorodifluoromethane, either as a vapor or as a liquid, is nonflammable, non-combustible, and non-explosive when mixed with air. It is non-toxic in concentrations as high as 20 per cent by volume for an exposure of 2 hours, and the vapor in any concentration does not irritate the mucous membranes. Leaks may be detected by a torch-like lamp burning alcohol. When air containing "Freon" is introduced at the base of the torch and the invisible alcohol flame is made to impinge upon a piece of metallic copper, the flame becomes bright green because of the formation of a volatile copper halide. In contact with a flame or very hot surfaces it will decompose into irritating toxic products, but such decomposition takes place slowly.

It is a stable refrigerant, withstanding repeated changes of state indefinitely, and has no corrosive action on any metal commonly used in refrigeration units. Magnesium alloys must be avoided, however. Mineral oils are used for lubrication. They mix with dichlorodifluoromethane, and must be dehydrated before use.

"Freon" products are colorless and odorless in concentrations below 20 per cent by volume. "Freon 12" has a boiling point of $-21.7°$ F. at atmospheric pressure, a condensing pressure of 93.2 pound gauge at 86° F., a vaporization pressure of 11.81 at 5° F., and a latent heat of vaporization of 69.47 Btu per pound at 5° F. Since the refrigerating effect of dichlorodifluoromethane is only about one-third that of sulphur dioxide, a larger volume of the refrigerant must be circulated, with the advantage of using less sensitive valves, which have a more positive regulating mechanism.

"Freon 12" dissolves natural rubber used in gaskets but has no action on synthetic rubber. The vapor is not absorbed by foods stored in the cabinet and has no effect on their odor, color, taste, or structure.

Ammonia. Ammonia, a colorless gas of characteristic odor, is flammable and explosive under certain conditions but not commonly under conditions found in the home; it has no corrosive action on iron

or steel but does corrode copper, especially in the presence of moisture. Leaks may be detected by a sulphur candle.

Ammonia boils at −28° F. at atmospheric pressure, has a latent heat of 565.0 Btu per pound at 5° F., a vaporization pressure of 19.57 pound gauge at 5° F., and a condensation pressure of 154.5 pound gauge at 86° F. Ammonia is very soluble in water, about 900 volumes of ammonia being soluble in 1 volume of water at ordinary temperatures. By weight, water absorbs about 40 per cent of its own weight of ammonia. The ammonia and water form an unstable union, readily separated again by heat. Its reaction with water causes the ammonia to be used in the absorption rather than in the compression system in household types of refrigerators. The fairly high condensation pressure necessitates cylinders and pipes of heavy construction.

According to H. D. Edwards, certain properties of a refrigerant may be determined from the chemical formula. If the formula has no hydrogen component, the refrigerant will not burn. When it contains hydrogen, it is usually combustible if mixed with air. When it contains hydrogen and chlorine and fluorine, either or both, it is harmful to man if breathed. If chlorine or fluorine are present and the refrigerant burns, the products of combustion are harmful. Refrigerants containing chlorine and flourine are decomposed in a flame to form harmful products.

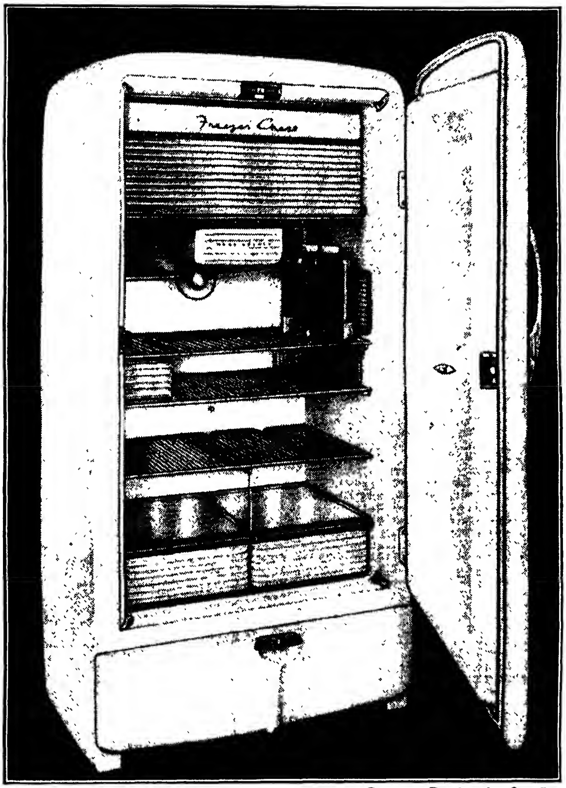
Advantages of each system

The absorption system is sealed, so there is little possibility of leakage. The condensing pressure of ammonia, however, is high, and heavy steel cylinders and pipes of one-piece construction are required. Refrigerators burning gas must be connected to a source of supply in a stationary position. When oil is used, it is necessary to fill the tank from time to time. This type of refrigeration is noiseless because of the absence of moving parts. For the same reason, wear on the mechanism is reduced to the minimum.

The compression system is somewhat more flexible in that the refrigerator may be plugged into any wall outlet. The expense of running an electric refrigerator is greatly reduced, however, if the refrigerator is connected to the power circuit on which there is a lower rate. There is always some noise when the motor is running, but research by manufacturers has reduced this to the minimum. After some years of operation, the noise tends to be more pronounced, but it is to be expected that any mechanism in continuous use will gradually wear out. The sealed-in unit is usually quieter than the conventional.

Special features

Different makes of refrigerators feature certain specialties that add to the convenience or attractiveness of the machine. Some of these have been mentioned previously. The door may be opened by a foot

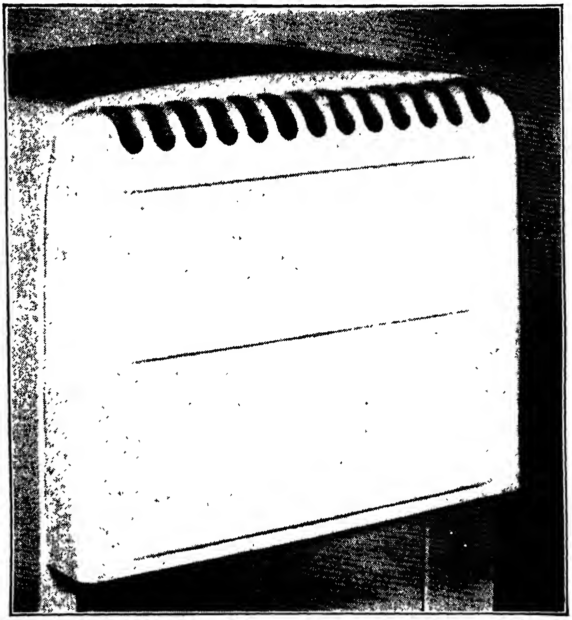


Sears, Roebuck & Co.

Fig. 120. Divided shelves provide for more flexible arrangement of food. A bin beneath the cabinet stores non-refrigerated foods.

control as well as by hand; an interior light may be automatically switched on as the door is opened; sliding shelves which do not tip when pulled out permit easy access to foods; a basket shelf with a surrounding guard rail keeps small storage utensils from slipping off; adjustable shelves accommodate containers of varying sizes, or allow the storage of a watermelon or turkey. (Fig. 120.) In some models a bin or cellaret compartment has been constructed in the front of the space occupied by the motor and condenser, where root vegetables, fruits, and beverages not needing constant refrigeration may be stored.

At least one company refrigerates this space. A wire egg basket, a covered pan for succulent vegetables, a meat pan directly beneath the evaporator, a special butter compartment maintained at 50° F., and a reservoir for drinking water are other accessories. One manufacturer claims to sterilize the air in the refrigerator with an ultraviolet lamp, destroying the surface growth of bacteria and molds.



Sears, Roebuck & Co.

FIG. 121. A back-mounted compressor system. Note louvers for removal of heat.

Certain improvements have increased the efficiency as well as the convenience of household refrigerators. Cabinet doors have a flush closing. They are frequently lined with plastic, an excellent insulating material. The food compartments are wider and shallower so that food receptacles are more easily removed. A spring arrangement holds the evaporator door in an open or tightly closed position. Compressor and condenser are smaller and more carefully protected from dust. This increases the space in the food chamber but tends to lower the bottom of the compartment so that more stooping is required. Circulation of the refrigerant is more positive; it flows through a larger number of channels in the evaporator, covering more surface and hastening refrigeration. Larger evaporator sleeves provide addi-

tional space for frozen foods. The sleeve is completely enclosed to aid in maintaining lower temperatures. Some refrigerators have a separate freezing locker that will hold 30 to 50 pounds of food at a temperature of 0° F. In certain cases, as noted, the evaporator and food compartments of electric refrigerators have been separated, decreasing the dehumidification of the foods.

Especially noteworthy is the construction of refrigerators with increased cubic foot capacity, which, nevertheless occupy the same floor space as the smaller models did. One manufacturer, for example, builds an 8-cubic-foot box, with 3.7 square feet of additional shelf area, that uses the same floor space formerly occupied by a 6-cubic-foot refrigerator; another mounts the motor, compressor, and condenser in a separate compartment attached to the back of the refrigerator cabinet. (Fig. 121.) Crispers for fruits and vegetables have been made deeper, too, to accommodate heads of cauliflower and cabbage more easily. The meat keepers are also deeper.

Range of temperature

The coldest place in the ice refrigerator is in the down-drop of cold air from the ice chamber. In the top-icer this place may be the center section of the top shelf of the food compartment directly below the opening through which the cold air falls, or it may be in the center of the chamber floor. The coldest location in the mechanical refrigerator, outside the unit sleeve, is immediately under the unit. The temperature in the coldest location should be 45° F. or less, but a temperture below 40° F. is costly to maintain and unnecessary for usual food preservation.

The warmest section is that through which the air circulates last before passing over the ice or evaporator. Most authorities agree that the temperature here should not be over 50° F. It is important to know the maximum and minimum temperatures that a refrigerator will hold under varying conditions; the average temperature is of comparatively little importance.

Location of foods

Milk, and sauces and desserts containing this product, and other protein foods such as meats, poultry, and meat broths are most liable to spoilage and should always be kept at 45° F. or below if they are to be held for more than a few hours. Eggs and small fruits—strawberries, cherries, raspberries—are given the next coldest place. Berries should be picked over and the bruised fruit removed before storage.

Salad vegetables occupy space near the fruits. In the warmest location strong-flavored vegetables and fruits find their place when it is necessary to store them at refrigerator temperatures.

Do not clutter up the refrigerator by storing foods that do not require refrigeration or will later be discarded. Jellies, pickles, commercial salad dressing, peanut butter, mustard, vinegar, etc., come under the first heading. Carrot, celery, and radish tops, outside lettuce leaves, pea pods, store wrapping-paper, and cardboard cartons are examples of the second group.

Types of containers

Although cold air can hold less moisture than warm air, foods stored uncovered at any temperature will tend to dry out unless the

Fig. 122. Various types of containers for storage of food in the refrigerator.

relative humidity is approximately 100 per cent. Manufacturers have tried to solve this problem in various ways. Those marketing ice refrigerators believe that the presence of the melting ice supplies sufficient moisture. For some years, the mechanical refrigerator manufacturer has provided covered containers to preserve the crispness of succulent vegetables.

Containers are of various kinds: hydrators of porcelain enamel, with or without openings for ventilation; opaque glass dishes in a variety of shapes and sizes; bags of oiled silk or plastic and covers of the same material to be used over bottles and bowls (they often have eyelets for ventilation); and seal sacks with zipper or slide fastenings. (Fig. 122.) They are all used to decrease the evaporation of moisture from the food and also to aid in preventing spread of odors. Less moisture is lost if the container is comparable in size to the food to be

stored. Moistureproof bags are, accordingly, especially satisfactory for storing small amounts of succulent vegetables and have the added advantage of requiring the least space in the refrigerator.

The covered hydrator pans should be of non-corrosive material. They are usually of porcelain enamel on steel, with covers of the same material, or of glass or aluminum. They maintain a humidity of approximately 90 per cent when the temperature is 40° F.

Extensive tests in the household equipment laboratories have shown that fresh succulent vegetables, unless protected with a skin, should be stored covered in all types of refrigerators. Vegetables containing a high percentage of water, such as lettuce and celery, keep best when stored tightly covered; others—beans, carrots, etc.—are stored preferably in a ventilated container. Raw meat should be covered lightly with waxed paper. Other protein foods and cream and butter are always covered. Raspberries, strawberries, and similar fruits remain in a more desirable condition if stored in ventilated containers, but peaches, plums, and pears are protected by their skins against dehydration. Strong-flavored fruits and vegetables tend to contaminate the air of the refrigerator and should accordingly be stored in covered containers or wrapped in waxed paper. Leftovers remain fresh longer if stored covered.

Cobb and Breckenridge found in repeated experiments that food in tin cans, placed in the refrigerator, cooled more rapidly when the paper label was left on the can than when it was removed.

The location of the humidity drawers is more flexible in new refrigerators than in prewar models. In some refrigerators they are placed at the bottom of the food chamber; in others, one above the other in racks below the evaporator. The drawers normally located across the bottom of the food compartment may also be stacked, leaving extra space for bulky foods. Sometimes the lower surfaces of the drawers are ridged to keep the food from excess moisture.

Ice trays

Ice trays are commonly made of aluminum and sometimes of plastic or rubber, in various sizes. Rubber and plastic trays are flexible and permit an easy removal of cubes, but this advantage is no longer emphasized since metal trays have been fitted with a shelf release and some type of ejector for freeing cubes from the sections, one at a time or by the trayful. The metal tray may be permanently wax treated to increase ease of cube removal. The waxed surface is not affected by hot water. Cubes freeze somewhat more slowly in rubber

trays, since rubber does not conduct heat and cold as readily as metal. Trays should be filled to within ¼ or ⅛ inch from the top edge to allow space for expansion of the ice and, in some trays, to permit operation of the cube release. The ice trays are sometimes used for making frozen desserts.

Frozen desserts

Frozen desserts are classified into ice, sherbet, ice cream, mousse, and parfait, depending upon the method of preparation. When they are frozen in the trays of the mechanical refrigerator, they often tend to be coarser in texture than when frozen in the freezer fitted with a dasher. Certain precautions must, therefore, be taken to insure small crystals. It is recommended that the mix be stirred or preferably removed to a chilled bowl and beaten when it has frozen to a firm consistency but still is not hard. The adding of small amounts of interfering agents also assists in preventing the growth of crystals. These substances include gelatin, cornstarch, marshmallow, tapioca, cream, eggs, Junket—in fact, any material that makes the mixture more viscous and so coats the crystals and prevents their growth. Sugar should be dissolved, since it is itself crystalline, and can form the nucleus around which a crystal may grow. Cream should not be beaten to a stiff consistency—it should hold its shape but still flow from the bowl. Day-old coffee cream is better to use than a heavier cream. In general, the homemaker should make only those frozen desserts that cannot be readily purchased. In most parts of the country many ice creams and sherbets are less expensive to buy than to make, even disregarding the time and effort involved.

Location of refrigerator

Since heat is given off when a refrigerant liquefies, space should be left at the back and above the top of the mechanically operated refrigerator for the heat to rise and dissipate. From 12 to 18 inches above and 2½ to 4 inches at the back are suggested as the minimum to allow free flow of air. If the refrigerator is between storage cabinets, at least 1 inch should also be left at either side. If sufficient free space is not available behind and over a gas refrigerator, the construction of a flue back of the wall cabinets is recommended. (See Fig. 176, p. 311.) Manufacturers usually also leave an opening beneath the front leg apron. The cabinet should be placed level and in as cool a location as possible, out of direct sunlight and away from the range and house-heating equipment.

Care

Since the preservation of food is the main purpose of the refrigerator, it must be kept spotlessly clean at all times. If the external finish is varnished wood, it may be dusted whenever other pieces of furniture are; if of lacquer or porcelain enamel, it may be wiped off as frequently as the range or kitchen table is wiped.

The inside of the refrigerator should be kept clean and dry. No dirty containers or foods should be placed in the cabinet, spilled food should be wiped up immediately, and the shelves and walls should be wiped dry from any deposited moisture.

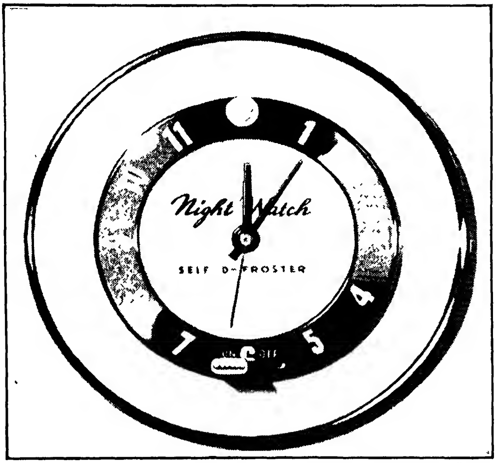
The ice refrigerator should be completely cleaned once a week or when reiced. Remove the ice rack, shelves, and drain pipe, wipe the entire interior with a cloth wet with soda or borax water (2 tablespoons to a quart of water), wipe again with a cloth wrung from clear cold water, then dry thoroughly. Wash the rack and shelves in warm soapy water, rinse in clear water, and dry. Pour hot soda or borax water through the drain pipe. If necessary, use a stiff long-handled wire brush to remove any deposit of slime. In a similar manner clean the water seal and the drip pan beneath the cabinet. Replace all parts as quickly as possible to conserve the cool temperature.

Mechanical refrigerators usually have a drier interior atmosphere than the ice refrigerator and may require less frequent cleaning. Cleaning at the time of defrosting is recommended. Wipe the unit as well as the inside walls with the soda or borax water. Empty the ice trays, wash in warm soapy water, rinse, and refill. Wash the rubber gasket with warm soapy water, rinse with clear water, and dry. Food and grease should be wiped from the gasket immediately. Grease causes natural rubber to become soft and sticky; even oily secretions from the skin will cause it to deteriorate; so fingers should not touch the gasket. Gaskets of synthetic rubber are less easily damaged.

Whatever the type of mechanical refrigerator, occasional defrosting of the cooling unit is usually necessary. Frost is deposited when the circulating air, laden with moisture, passes over the unit. It varies in density and structure, depending upon the way in which it is formed and its age. The first deposits of moisture freeze to a spongy brittle mass, but as more and more condensation occurs the density increases and gradually a coating of solid ice is produced. The amount of frost may be diminished by keeping foods of high water content in covered containers. Cold wall types of refrigerators may not need defrosting as frequently as other types.

Defrosting is advisable before the deposit is ¼ inch thick. Ice on the coils acts as an insulator, rapidly cuts down the efficiency of the evaporator, and forces the motor to run a higher percentage of the time. Some refrigerators have a small red indicator on the outside of the evaporator. When it is no longer visible, defrosting is recommended.

Units may be defrosted by shutting off the current or gas, or by filling the ice-cube trays with hot water and placing them inside the



Borg-Warner Corp.

Fig. 123. This timing device automatically defrosts the evaporator each night.

evaporator sleeve. The latter method is more rapid but it should not be followed unless advised by the manufacturer of the model in question. When hot water is used, the switch should be turned to the off position. Either method does not greatly increase the temperature of the cabinet, since ice in melting absorbs heat—probably not more than 8° or 10° when defrosting takes place overnight. Some models, as has already been noted, have a special circuit to which the machine is switched when defrosting is necessary. Defrosting takes place somewhat more slowly in this case, but the temperature inside the food chamber never rises above 50° F.

The drip water should be emptied as soon as defrosting is complete. Otherwise it may evaporate into the cabinet air and cause new frost to form immediately when operation begins again. It is good practice to remove the drip pan when it is not in use so that it will not hinder air circulation.

One manufacturer has supplied his control system with a timing device, which each night at a set time automatically defrosts the

evaporator coils. (Fig. 123.) The tray must be emptied in the morning.

Refrigerator condensers should also be cleaned if the air is to circulate freely around the coils. Dust and lint depositing between the baffles will shut off the circulation and hence hinder the cooling action. Check the condition of the coils regularly. A stiff brush or the flat tool of the electric cleaner will do a satisfactory job. Always disconnect an electric refrigerator before starting to clean the condenser.

Cost of operation

The cost of operation must be considered as well as the initial purchase price. The Bureau of Human Nutrition and Home Economics reports that the average monthly consumption of a 6-cubic-foot refrigerator, depending upon source of energy, is approximately:

700	pounds ice
15	gallons kerosene
30	kilowatthours electricity
1000	cubic feet natural gas
1800	cubic feet manufactured gas
50–55	pounds bottled gas

Although larger refrigerators are, in general, more expensive to operate, the difference in energy consumption between the 6- and the 8-cubic-foot boxes is very slight.

At the maximum flame setting, gas refrigerators use between 1800 and 2900 Btu per hour, depending upon the size of the food compartment. With a minimum gas flame, however, the refrigerator uses 750 Btu per hour, regardless of size.

Tests carried on year after year in the course in refrigeration at Iowa State College indicate that kilowatthour consumption is less when the refrigerator door is opened less frequently, even if for longer periods of time, than when opened more often for short periods.

It is advisable, therefore, to remove all the foods needed at one time, instead of taking out one or two articles and then repeating the operation in a minute or two. The same procedure should be followed in putting food into the refrigerator. The rise in the temperature of the food chamber was always more rapid during the first 30 seconds the door was open than in the succeeding seconds.

Initial cost depends in part upon the accessories supplied with the refrigerator, such as water pitchers, dishes for leftovers, and egg baskets. They may increase the cost out of proportion to their value. Strip models, so called, are just as carefully constructed and have

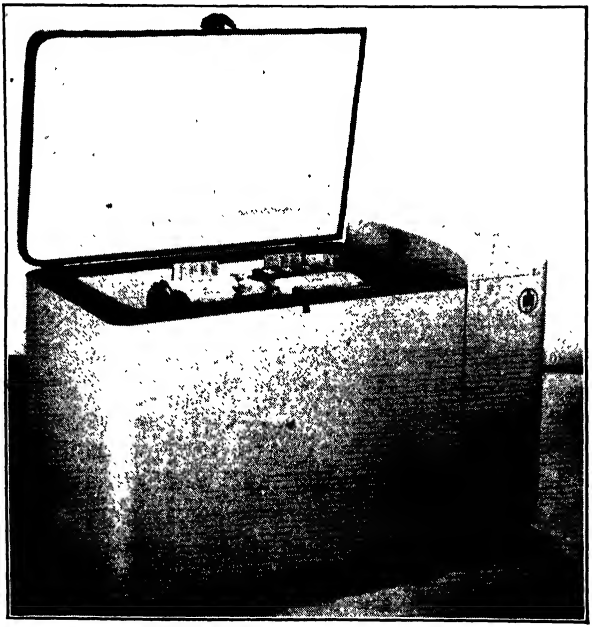
the same kind of a unit as the de luxe cabinets. They may have only one hydrator and perhaps no tray releases or divided shelves, but all the basic essentials are there. The homemaker must decide for herself whether the special features are worth the extra cost because they meet a particular need.

Guarantee

Refrigerators usually carry a guarantee. Most manufacturers guarantee the cabinet against defects in material and workmanship for 1 year and the refrigerating system for a period of 5 years. The purchaser should read the guarantee carefully to know definitely what it includes.

Home freezers

The increasing interest in preservation of foods by freezing has resulted in the extensive manufacture of home freezers. Two differ-

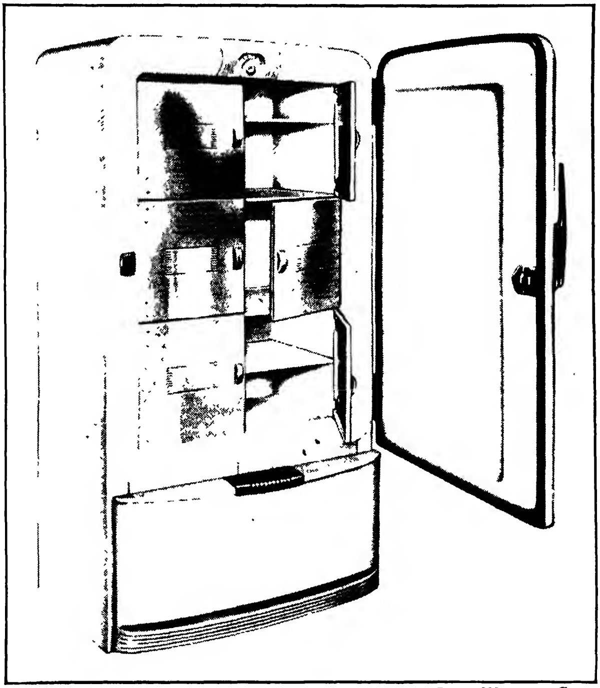


International Harvester

Fig. 124. Chest-type home freezer.

ent cabinet designs and a variety of sizes are available. (Fig. 124.) The chest type has a top-opening door or doors, and the vertical type has the front opening similar to the household refrigerator. One door

is preferred. The temperature gradient between room and cabinet space is large, much larger than in the household refrigerator, and the vapor pressure from the outside to the inside is accordingly high. The larger the number of doors, the greater is the opportunity for heat to leak into the box.



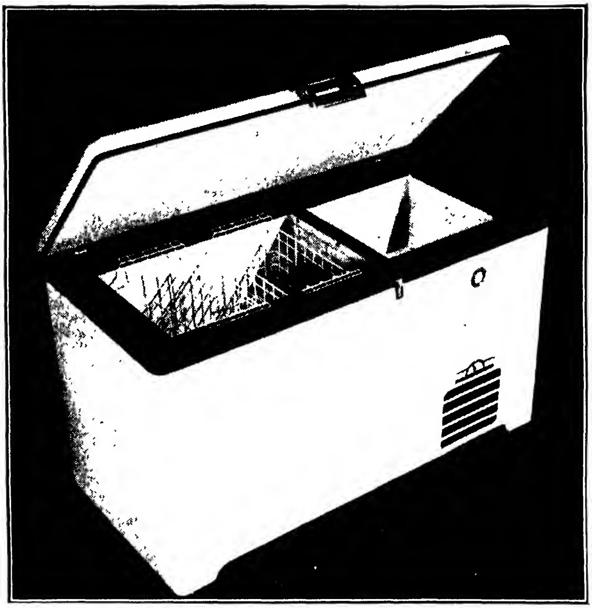
Borg-Warner Corp.

FIG. 125. Vertical-type home freezer with doors to inner sections.

There are certain advantages in each type of construction. When the cover of the chest type is opened, the cold air remains in the freezer, since cold air is heavier than warm air. The frequency of defrosting may, consequently, be reduced and the cost of operation decreased. The temperature varies throughout the storage compartment, being colder at the bottom and several degrees warmer near the top opening, a condition that may reduce sweating around the cover.

Since loss of cold air is more probable from the vertical freezer, the inside sections may have separate doors (Fig. 125) or be divided into a series of drawers; when a drawer is pulled out, the back panel blocks the space behind and prevents the escape of the cold air. The

foods are generally more easily removed from this type of freezer, and it occupies much less floor space than the chest type. Racks or baskets may be used in either cabinet for easy removal of packages. (Fig. 126.)



Coldspot, Sears, Roebuck & Co.

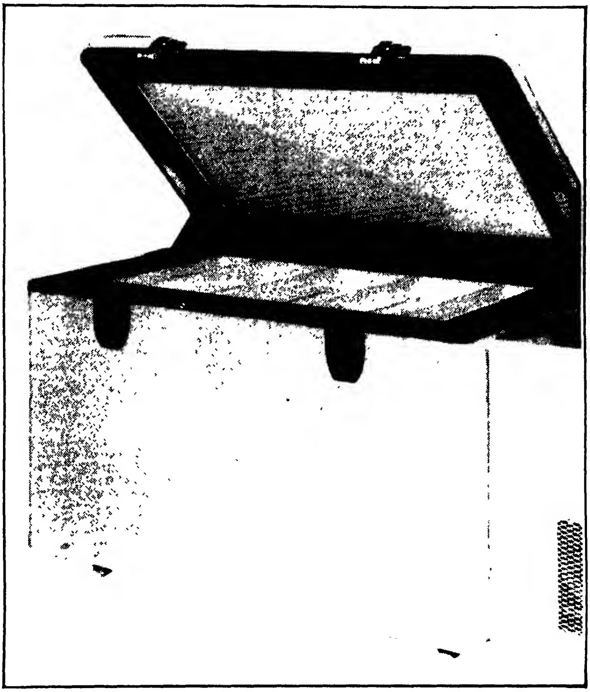
FIG. 126. Baskets aid in efficient storage of frozen-food packages.

CONSTRUCTION OF CABINET

Materials. Home-freezer cabinets are made of aluminum, steel, stainless steel, or galvanized steel, finished on the outside with synthetic enamel and on the inside with synthetic or porcelain enamel. Plastics are used for door linings and breaker strips. The breaker strip on the home freezer is important, since it must prevent heat conduction to the inner walls and sweating on the outside of the freezer. The hardware should be chromium plated and positive in action to maintain a very tight seal between the door and storage compartment.

Insulation. The insulating material must provide maximum protection against transfer of heat and at the same time prevent excessive bulk. The thickness required will be in proportion to the thermal conductivity. In most freezers, the insulation varies from 4 to 6 inches. It must be carefully sealed against moisture that will tend

to deposit in the interstices of the material and not only destroy its insulating efficiency but also have a tendency to corrode the inside of the cabinet panels. Double and single rubber gaskets are used to seal the door opening. The single gasket is usually preferred. (Fig. 127.)



R. H. Bishop Co.

FIG. 127. Wide single gaskets make a desirable type of seal.

When a double gasket is used, the vapor in the air between the two gaskets sometimes freezes out and causes difficulty in opening the door.

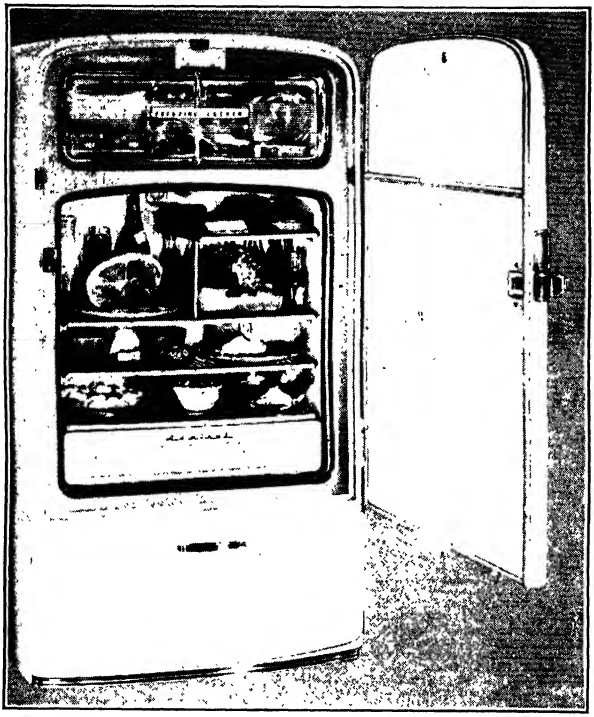
FREEZING SYSTEM

The present trend is toward sealed-in units for the small and medium-size home freezers, but larger ones have a belt-driven compressor. The evaporator coils may be within the insulated walls and entirely surround the cabinet, or they may be stamped into plates that become the inner walls of the cabinet or divide the sections. Sometimes they form horizontal plates on which the food packages are placed. In any type of construction the objective is to bring as much food as possible into direct contact with a cold surface for more rapid

freezing. "Freon 12" is the most widely used refrigerant, but "Freon 22" is used in a few cases. "Freon 22" is especially adapted for very rapid freezing where space and time are limited.

Types of freezers

Freezers vary in size from 3 to 32 cubic feet. The smaller ones, up to 8 cubic feet, are usually intended for storage only. They may be



Admiral Corp.

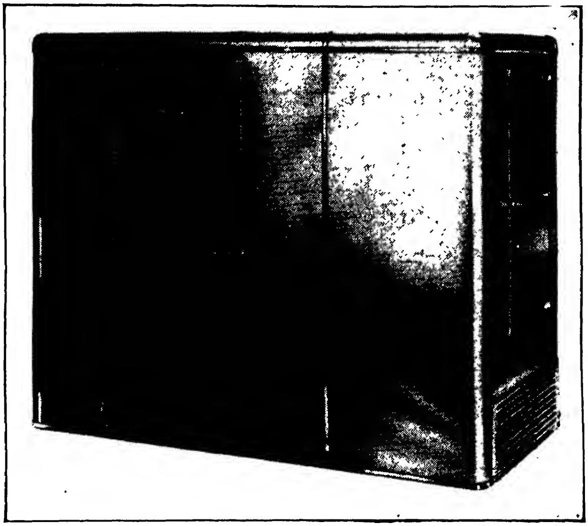
Fig. 128. A dual-temperature refrigerator. Note the two controls.

used to supplement the drawer at the locker plant, for storage of commercially frozen foods, or for storage of foods prepared at home and frozen in the locker quick-freeze section. A package or two may be frozen in this freezer, if necessity arises, but freezing of any large amount of food will cause the temperature of the rest of the food to rise beyond safe limits.

The standard home freezer unit has storage space frequently divided into two or three sections, and also a quick-freeze compartment. The temperature in the quick-freeze section varies from $-5°$ F.

to $-30°$ F., the lower temperatures being more satisfactory for rapid freezing but also more expensive to operate. Storage sections should be held at 0° F., as the maximum.

Dual-temperature or two-zone units are also available. They have two compartments, separately controlled, one for the storage of frozen products at 0° F., and the other with a temperature satisfactory for the preservation of non-frozen foods. One of these types of units



Refrigeration Div., Amana Society

FIG. 129. A walk-in freezer with quick-freeze section at right end.

is a self-contained cabinet, similar in appearance to the household refrigerator, with a frozen-food section capable of storing from 25 to 50 pounds of meat and packaged fruits and vegetables. The other section is used as any refrigerator. (Fig. 128.) In some two-zone refrigerators, the non-frozen-food section has the cold-wall type of construction.

The homemaker should differentiate between the genuine two-zone refrigerator and the usual household refrigerator with the compartment marked for ice freezing or frozen-food storage. This compartment is the conventional evaporator. The evaporator is usually easily distinguished by the shape, but sometimes it has been flattened out and placed across the top of the refrigerator above the food compartment, somewhat to the confusion of the homemaker. These large evaporators will store a much greater amount of frozen food than the older types, but the temperature in them usually fluctuates between

0° or a few degrees above, and 20° F. or higher, during each on and off cycle. Frozen food may be satisfactorily stored in the evaporator for 2 or 3 weeks but not much longer without the food's acquiring an undesirable flavor. In the true freezing compartment of the two-zone refrigerator the temperature is constantly maintained at 0° F. or lower.

The other dual-temperature unit is the walk-in freezer. It is built in sections which are usually assembled at the point where it is to be installed. It affords space for chilling and aging of meat and for bulk storage of fruits and root vegetables, such as apples, carrots, and potatoes, but also has a quick-freeze section and storage space for frozen foods. (Fig. 129.)

Defrosting

Home freezers are usually defrosted only once a year, at a time when the least amount of food is stored. Food remaining should be temporarily removed to the refrigerator evaporator. The frost may be removed from the inside freezer walls with a cold-water spray. Never use warm water, since it will tend to build up too high a pressure within the evaporator. Between defrosting periods, excess frost is removed from the inside surfaces by scraping with a blunt instrument such as a putty knife. Place the freezer in a dry, cool, well-ventilated location and frosting will be reduced to the minimum.

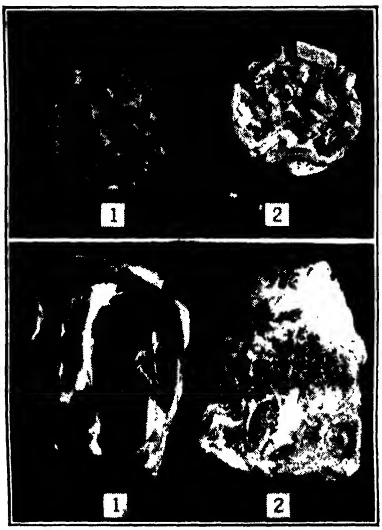


Fig. 130. Fluctuating temperatures have drawn moisture from samples of beans and beef. No. 1 product held at 0° F.; No. 2, temperature fluctuated 10° to 15° above 0° F.

Points to remember

1. Food is no better after it is frozen than it was before freezing. Select varieties most suitable for freezing and of the correct maturity.

2. Even at 0° F. or below, food will tend to lose moisture. Protect food with an airtight covering impervious to moisture. Fluctuations in temperature may draw the moisture from the food and deposit it in the form of frost on the inside of the package. (Fig. 130.) Such

fluctuations may occur when too large an amount of unfrozen food is placed in a partially loaded cabinet. The manufacturer should include in his instructions the maximum pounds of food that should be frozen at one time.

3. An alarm should be provided to notify the homemaker of failure of freezer operation, resulting in warm-up.

4. The more rapid the turnover in products stored in the home freezer, the less the cost of operation per pound of food stored.

Test specifications

Standard methods for testing household refrigerators have been approved by the American Standards Association. Similar standards have been adopted for both refrigerators and home freezers by the National Electric Manufacturers Association (NEMA). As a result of the test procedures, information is obtained on energy consumption, percentage of operating time, number of cycles per 24 hours, average temperature of cabinet air, and total pounds of ice cubes per freezing. Methods for determining the food-storage volume and shelf area of mechanical refrigerators are also outlined.

The Underwriters' Laboratories test for safety, i.e., fire, life, and explosion hazards. The purchaser should look for their seal on any refrigerator or freezer under consideration. A gas refrigerator should also carry the A.G.A. Approval Seal.

Summary

1. Food spoilage is caused by the growth of yeasts, molds, and bacteria. Refrigeration is essential for adequate preservation of foods. Cold and humidity are both necessary for optimum storage conditions.
2. Refrigeration is based on fundamental physical laws of heat transfer, latent heat, and specific heat. Cooling of the food chamber in all refrigerators is brought about by the absorption of heat during a change in state of the refrigerant.
3. There are two types of mechanical systems, the absorption and the compression. The compression system is electrically operated; the absorption system, by gas or kerosene. Economical operation of either type depends primarily upon efficient insulation.
4. Sulphur dioxide or one of the "Freon" refrigerants is used in the compression system; ammonia, in the absorption system.
5. Foods high in water content should always be stored covered. Fit the size of the container to the amount of food.

6. The refrigerator must be kept clean at all times. Defrost before the frost on the evaporator is ¼ inch thick. Frost acts as an insulator, causing the temperature in the box to increase, and forcing the unit to operate a larger percentage of the time.
7. Dual-temperature refrigerators and small home freezers are used primarily for storage of frozen foods. Larger home freezers may be used for freezing as well as storage. Food is no better after it is frozen than it was before; therefore, select desirable varieties of the correct maturity.

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10

Laundry Procedure

IT SEEMS A LONG STEP from the days when the family washing was done at the village stream to the modern equipment of the up-to-date home laundry, and yet today probably two-thirds or more of the world's housewives still wash in the primitive way, beating and rubbing clothing clean on smooth rocks by the side of a river or pond and spreading the clothes to dry on the near-by bushes or grassy bank. When a stream is not available, the women gather in the square at what might be described as a giant water trough and there side by side do their washing. However clean the clothing may be when washed by this method, it is frequently far from sanitary; and, when the same water is also used for drinking, spread of disease is inevitable.

Some of the first patents granted in the United States were for washing machines, many of which bore slight resemblance to those of the present. One was equipped with a double-action handle, like the walking-beam on a steamboat, with attached clamps, into which were fastened the articles to be rubbed up and down the two scrubbing boards.

It was only about 1910 that washers began to take the form they now have. Today more than 18,000,000 are in use in American homes, a number far in excess of the total used in all the rest of the world; in fact, more are used in one of the thickly populated states than in any other entire nation. It is an interesting observation that the extensive development of women's clubs and parent-teacher associations has been simultaneous with the evolution of the washer. Until it became efficient enough to make real saving of time in the home, women had little leisure to join in these cooperative activities. Manufacturers of other types of modern equipment might make the same claims for their appliances, but undoubtedly no other single task requires such great expenditure of energy as hand scrubbing.

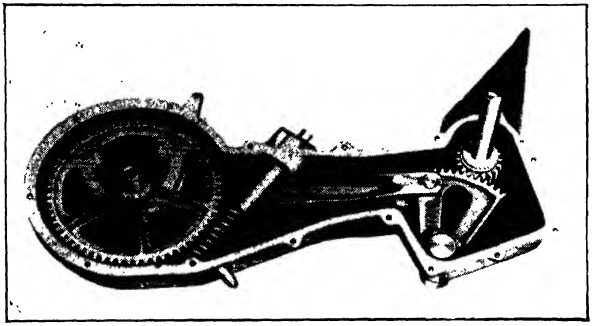
MOTOR

Washers and most ironers are motor driven. A motor is similar in structure to the generator (p. 54). In the generator the armature is

revolved in a magnetic field by means of mechanical power, and electromotive force is built up; in the motor the armature itself is connected to a source of electricity, and the attractions between the field of force set up by this current and the magnetic field between the poles of the surrounding field magnets cause motion. This motion is transmitted directly or by means of gears to the mechanism of the appliance.

Gears

Gears used in washers are usually of four common types: spur, rack and pinion, bevel, and worm. In spur gearing, the axes of the inter-



One-Minute Washer Co.

Fig. 131. Gears transmit the energy of the motor to the mechanism of the washer.

meshing toothed wheels are parallel. The wheels may be the same size or may vary in size. When the radius of one of the wheels is greatly increased, so that only a small portion of the toothed circumference is used, and the teeth mesh along a line that tends to become straight, the gear is the rack and pinion. A bevel gearing has intersecting axes and the pitch surfaces are cones, with a common apex at the point where the axes intersect. In the worm gear, a screw rotates tangentially to a toothed wheel and in so doing imparts a continuous motion to the wheel. The axis of the worm is at right angles to the axis of the wheel. (Fig. 131.)

Bearings

In changing the electrical energy of the motor into the mechanical energy of the washer, there is a certain loss due to the friction of the brushes and revolving shafts and gears. To reduce this friction as much as possible, bearings are used. Depending upon the type of bearing, point, line, or surface contact is obtained. The ball bearing,

formed of two concentric rings with a number of metal balls between them, makes point contact, since a surface can be tangent to a sphere at only one point. This bearing reduces friction to the minimum. Roller bearings, which are in the form of cylinders, have line contact with tangential surfaces. When the shaft rotates in a bushing or sleeve there is surface contact. Friction is greatest in this case and is minimized as far as possible by using one kind of metal for the shaft, another for the sleeve. In some washers the sleeve bearings in which the wringer shafts rest are of wood, which may be successfully lubricated with soapy water. In other parts of the machine, oil is used to lubricate the bearings, but is not used on the wringer shaft because of the likelihood of damage to the clothing.

Dirt

Several kinds of dirt or soil are present in a family wash. Dirt from mud and dust is largely inorganic in nature and fairly easy to remove. Organic dirt consists of food spots and stains, albuminous matter, grease, body excretions of oil or waste epithelial cells, and bacteria. Dirt on overalls differs from dirt on a tablecloth, and that in turn from dirt on a neck band.

The nature of the washing varies with the kind of dirt, and it is apparent that no one method of treatment is equally efficacious in all cases.

Surface tension and adsorption

Dirt removal depends upon the reduction of the surface tension of the water by soap or other cleaning agent, and the emulsification and adsorption of the dirt by the soapy solution. Surface tension is the force that causes a liquid to take a form that will give the least surface area; that is, a sphere. Liquids of low surface tension form small drops and wet the surfaces with which they come in contact more readily than do liquids of high surface tension. Adding soap reduces the surface tension to about one-third that of pure water. Millard found that sodium carbonate was the most effective alkali in reducing the surface tension of soap solutions and that soap-soda solutions have the lowest surface tension of any liquids. Although it is true that the detergent value of a solution is not wholly dependent upon the amount of surface tension, nevertheless there seems to be a close relationship between decreased tension and removal of dirt.

Adsorption is the adhesion of dirt particles to the surface of soap bubbles. Inorganic soil, i.e., dust and mud, are removed in this way. Soap emulsifies the greasy material that is mixed with the dirt, hold-

ing it in suspension until it can be removed by the mechanical agitation of the washer. Some investigators believe that there is a chemical reaction between the soap and certain dirts, although definite proof of such reaction has so far not been obtained.

Hard water

Water as well as soap has an important influence upon the efficiency of the washing process. Hot water is a prerequisite, not alone for cleaning action, but also for sterilization. Water heaters are discussed in detail somewhat later in the chapter (p. 271). Ease of washing depends upon the softness of the water. Temporary hardness may be removed by boiling, but permanent hardness must be treated in some other way. Soap itself is a water softener, and some soaps contain added ingredients such as borax, soda ash (Na_2CO_3), or sodium silicate to aid in softening. Extremely hard water requires so much soap—even twice the amount used with soft water—that the operation is expensive, especially so when a neutral soap is used. Soap reacts with minerals in hard water to form a scum which often deposits in the fibers of the cloth and is rinsed out with difficulty, so that in time the clothes develop a gray or streaked appearance. Hard water tends to damage the fibers and make clothing harsh to the touch. Continuous use of hard water may shorten the life of clothes as much as 40 per cent, resulting in waste costing as high as $100 a year.

The following table,[1] based on a U. S. Geological Survey of 300 cities, shows the distribution of areas of varying degrees of hard water over the country:

0 to 3 Degrees (Grains per U. S. Gallon) ("Soft")

Requires 0.12 to 1.75 ounces of neutral soap to soften 16 gallons of water.

Maine, Vermont, New Hamphshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Washington, Oregon.

3 to 6 Degrees ("Moderately Hard")

Requires 1.75 to 3.0 ounces of neutral soap to soften 16 gallons of water.

Pennsylvania, West Virginia, Kentucky, Tennessee, Montana, Idaho, Nevada.

6 to 12 Degrees ("Hard")

Requires 3.0 to 5.3 ounces of neutral soap to soften 16 gallons of water.

Ohio, Michigan, Wisconsin, Chicago, Ill., Minnesota, Missouri, Arkansas, North Dakota, Texas, Wyoming, Utah, Colorado, New Mexico, California.

[1] From The Problem of Hard Water, *Bul.* 9, The Easy Washing Machine Corp.

12 TO 30 DEGREES ("VERY HARD")

Requires 5.3 to 11.4 ounces of neutral soap to soften 16 gallons of water.
Florida, Indiana, Illinois (except Chicago), Iowa, South Dakota, Nebraska, Kansas, Oklahoma, Arizona.

It should be noted that waters containing minerals in excess of 3 grams per gallon are considered hard.

SOAPS

It is estimated that 80 per cent of the American families' personal and general laundry is washed at home; yet soap used for this and other purposes costs only between $10 and $18 a year per family. Time and labor would be saved and in many instances fabrics would be cleaner and wear longer if consumers knew more about buying soap and other cleansing agents and knew how to use them correctly.

Soap is the product resulting from the action of an alkali on animal or vegetable fats. A single fat is rarely used but several are combined, the kinds varying with their availability and the type of soap to be produced. Tallow and coconut oil are the two that were most commonly used before the war. During the war, soybean oil and cottonseed oil were widely used and also various mixtures of household greases, which have always been an ingredient of homemade soaps. Coconut and palm-kernel oils make soaps that lather quickly and abundantly even in hard water. Hard-water soaps, accordingly, contain 20 to 30 per cent of coconut oil and usually some sodium silicate or carbonate.

Rosin is also used in soap to increase the lathering properties. It unites with a part of the alkali. Satisfactory laundry soaps do not have more than about 20 per cent of the rosin-alkali combination and not more than 0.02 per cent of free alkali (calculated as $NaOH$). Larger proportions of rosin tend to make the soap sticky. Rosin soaps are yellow and are purchased in bar form. White bar laundry soaps often contain silicates as builders. Builders are alkaline substances which aid in softening hard water and promote the cleaning action by combining with the grease on badly soiled clothes. Built soaps should contain not less than 50 per cent of pure soap. Soaps suitable for laundering silks, woolens, and delicate fabrics should be "neutral," i.e., contain no free alkali.

Soaps may be purchased in the form of cakes, flakes, chips, beads, and powders. Both flakes and chips are made by running liquid soap over cooling rolls and scraping off the thin hard layers. Flakes are usually of the same composition as pure neutral cake soap; the thicker

chips frequently contain builders that tend to increase the detergency. Chips or flakes may be pulverized to form powdered soap, or it may be made by spraying hot liquid soap in a tower. Beads and grain soaps are produced by a similar process. A careful distinction should be drawn between powdered soaps and soap powders, the latter usually containing washing soda or silicates.

As has been noted, the kind of soap selected is determined in part by the hardness of the water. Another essential factor in the choice is the fabric to be laundered. In some instances pure neutral soaps must be used; in others, a laundry soap to which supplementary detergents have been added is preferable. For economy and efficiency excess of soap should be avoided. Rhodes and Brainard found that a concentration of soap in the wash solution of approximately 0.25 per cent gave optimum results; in higher concentrations there was little increase in cleaning action. In general that soap should be chosen which will restore the fabric to its original state without impairing its appearance, texture, or color.

Soapless detergents

During and since the war many soapless detergents or synthetic detergents, as they are also frequently called, have appeared on the market. A few had been developed earlier but not for general household use. In 1946 about 125 million pounds of these detergents were manufactured and almost twice that amount in 1947. It is estimated that within a few years as many as a billion pounds may be made annually. Such an amount would be about 25 per cent of the yearly production of soap.

Made at first for use in the textile industry, synthetic detergents are now finding wide application in the home. They are readily soluble in water of low temperature, even in hard water, and form a neutral or slightly acid solution with no precipitate or scum; consequently, they are not wasted in softening the water and hence are economical. They have desirable wetting, dispersing, and penetrating qualities and cause water to penetrate fabrics rapidly and thoroughly. They are often good foaming substances, but the foam is usually not as long lasting as soap foam.

For the most part, soapless detergents are sulphated fatty alcohols and esters, although the exact formula is usually not made public. They are crystalline bodies, commonly marketed in the form of flakes, beads, and powders. Occasionally sodium sulphate is added as a builder. It tends to lower surface tension and increase the sur-

face action of the detergent, but it also decreases the soil-removing ability slightly.

So far most soapless detergents have proved effective aids in the washing of woolens and certain fine fabrics of silk and nylon, but Richardson found them not so successful in the laundering of linens, cottons, many rayons, and other heavy or badly soiled fabrics of mixed yarns. They also were not as satisfactory as soaps for washing babies' woolen garments which had food stains. They do not cause as much fading of colored cottons as soap, but, just as they will make a dye penetrate cotton and linen fibers, so they may cause soil to diffuse into the material, giving a spotty appearance to the garment. Present investigations are expected to produce synthetic detergents in which these disadvantages will be overcome so that they may be used equally successfully with all fabrics.

Stains

Most common stains are easily removed if treated promptly, and they should always be removed before laundering. Stains usually penetrate more deeply into the fibers of the cloth than ordinary soil, which clings to the surface, but the majority of them may be washed out by the application of water of one temperature or another; and water should be tried first. It is well to experiment with a separate piece of the material or, lacking that in a ready-made garment, the inside of hem or seam or end of the belt.

Grease. Cold soapy water and gentle rubbing between the fingers will remove many grease stains. Dampen petrolatum and oil spots with kerosene and wash. Tar and heavy oils may be dissolved by applying lard, rubbing it well into the fibers of the cloth, and then removing it with cold soapy water. Finally wash the material in warm soap suds. If hot water is used before the grease is dissolved, the stain is set in the cloth and is removed with great difficulty. Fabrics that cannot be washed may be treated with carbon tetrachloride, using an absorbent pad beneath the material to prevent forming a ring, and sponging gently from the outside toward the center of the spot.

Fruit and vegetable stains of a red or purple color, and tea and coffee stains, are removed by pouring hot water through the fabric, preferably from a height of 1 or 2 feet. Peach stains if treated when fresh will disappear in a cold-water bath, but if overlooked they will be "set" by hot water.

Mildew is a fungus that grows on clothing allowed to lie around in a damp condition during the warm summer months. In the early stages it may be removed in cold water. More persistent growths are treated with Javelle water (a tablespoon of Javelle water to 1 quart of warm water), if the material is white. Javelle will bleach colored goods. Careful rinsing is essential; otherwise Javelle water weakens the fibers.

Blood stains soak out in cold water. Many fresh *ink spots* will also disappear in cold water. Ink made from iron compounds and iron stains may be removed with a solution of oxalic acid. It is a poison. After the application of oxalic acid, use a weak solution of household ammonia to neutralize the acid, and then rinse carefully.

India ink contains a carbon compound that may be treated with lard and then one of the solvents previously noted. Marking inks owe their durability to the presence of silver salts, but may be removed with sodium hyposulphite, which is not harmful to the cloth. Indelible pencil marks should be moistened with denatured alcohol and washed.

Ether and chloroform dissolve iodine stains but should not be used on acetate rayons. Many medicine stains may be removed with alcohol. When wash materials are badly stained with perspiration, they should be soaked in a strong salt solution before washing. Grass stains may be removed by warm soapy water, or, if that is unsuccessful, use denatured alcohol.

Sugar and sirup stains disappear in warm water. When stains are caused by *chewing gum or colored candles,* remove any particles adhering to the fabric, moisten with turpentine, and wash in warm soap suds. When the garment is non-washable, sponge with naphtha. Always use naphtha out of doors, since it is highly flammable.

Water spots may often be removed by rubbing the spot with another piece of the same material. If this method is not efficacious, the garment will have to be completely sponged. Before making up silk goods, they should be tested for dressing that will cause water spotting. To prevent this spotting in wools, dressed wool materials should be sponged and shrunk before they are made into garments.

Try to fit the method of stain removal to the type of stain and the kind of fabric. Use a clean soft cloth for sponging. Label all bottles and store them out of the reach of children. Use flammable solvents out of doors, and avoid excessive friction. Severe burns have resulted from the hard rubbing of materials soaked in naphtha.

EFFECT OF WASHING ON FIBERS

Fibers of the fabrics commonly laundered are of vegetable or animal origin, some of the vegetable of synthetic manufacture. Cotton and linen are plant fibers; silk and wool, animal. The latter are easily damaged by strong alkalies; their fibers are weakened and turn yellow. Water that is too hot has a similar effect, causing silk to yellow and streak and wool to shrink and mat. Wool contains a natural oil, lanolin. When this is neutralized by alkaline soap or dissolved out by water that is too hot, fibers become hard and brittle and tend to shrivel. Wool fibers are also very sensitive to scrubbing or any hard rubbing; the tiny barbs on the fibers interlock and give a firm felted effect instead of the desired fluffiness. Loosely woven woolens should be washed as rapidly and as gently as possible in water of moderate temperature and rinsed in water of the same temperature. If the washer has vigorous action, fine woolens should be washed by hand.

Blankets should always be washed one at a time in a full tub of lukewarm, very sudsy water and for not more than 3 minutes. Do not allow a blanket to become very soiled before laundering; but, if it has, and the 3-minute washing is not sufficient, do not wash it longer in the same water, but use a second tub of soapy water of the same temperature. Soiled bindings may be given a slight rubbing with a soft, wet brush. At the end of the wash period, lift the blanket out in one "lump"—never pull it out, and rinse it several times in water of the same lukewarm temperature. After rinsing, surplus water may be removed with the centrifugal dryer or by running the blanket through the wringer, released to its loosest adjustment. Drying should be done in medium-warm air, never very hot or cold.

White cottons and linens are not damaged by hot water and can stand considerable rubbing, but colored materials tend to fade. Inexpensive fabrics often have the surface finished with starch or other dressings to give an appearance of firm weaving and good body. During washing such finishes are removed, leaving a flimsy material. Vegetable fibers are injured by the strong acids sometimes used in bleaches. Although a small amount of bleach may improve the color of white fabrics, any bleaching impairs the strength of the fibers and should be done with care at a low temperature, followed by a thorough rinsing.

Synthetic fibers are of several diffetent kinds, depending on the method of manufacture. Viscose and acetate fibers are most widely used, the acetate fabrics being best known under the names Celanese, Acele, etc. They are made from cotton or wood pulp, treated chemi-

cally to form a solution, which is forced through tiny holes under pressure to form filaments. The filaments are used like silk threads. Some rayons lose a large percentage of their strength when wet and must be handled with care during the washing process. Most varieties can, however, be washed satisfactorily in the washing machine. Acetate is easily melted and cannot be ironed with a hot iron.

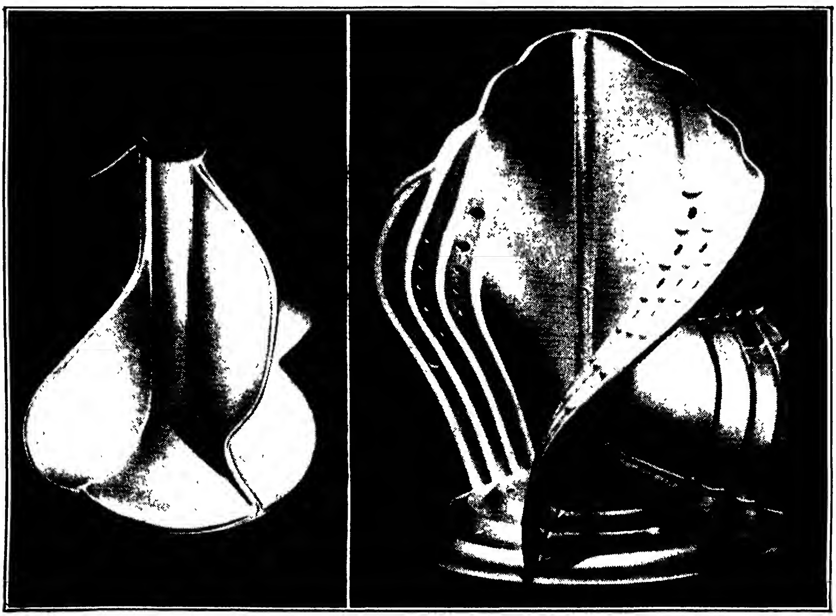
Silk garments should be washed frequently, in fact after each wearing is a good rule to follow, for they absorb perspiration, which weakens the fibers, causing them to disintegrate.

Whatever the problem with regard to temperature, soap, water, and fabrics, the washing itself is completed most efficiently and with the smallest expenditure of time and energy if a mechanically operated washer is used.

WASHERS

Types

At present there are about forty companies in the United States manufacturing washers. They make both automatic and non-automatic or conventional models. Washers are of three general types; agitator, vacuum cup, and cylinder. The agitators may differ greatly

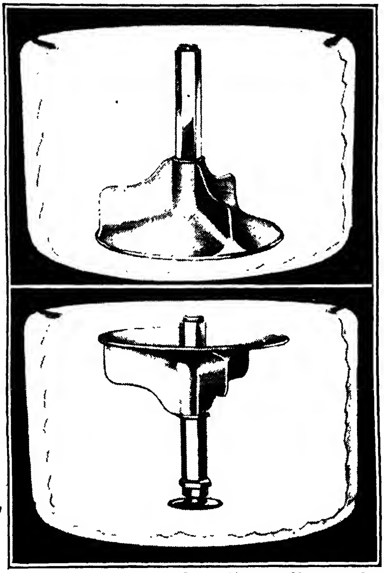


Duchess Appliance Mfg. Co. *Apex Rotarex Corp.*

Fig. 132. Types of agitators.

from one another. Figure 132 shows two of the types. These spiral-type agitators have been featured in several postwar washers.

The agitator fits over a central shaft. The blades, fins, or vanes—some manufacturers use one term, others, another—vary in number and shape; some blades are short and thick, extending horizontally, others are thin and high. One model has very broad blades; another, blades of two different sizes. They may be corrugated or perforated. Some agitator blades are designed to give washing zones, gentle action at the top, vigorous at the bottom. One agitator is made of a plastic. The standard agitator is at the bottom of the shaft, but at least one manufacturer builds a washer in which the agitator may be turned to operate toward the top of the water for the washing of blankets and delicate fabrics. (Fig. 133.) Research work carried on in the equipment laboratory at Iowa State College indicated that agitators with four blades were, in general, more efficient in removing soil than those with a fewer or larger number of blades.



One-Minute Washer Co.

FIG. 133. The duo-disk reversible agitator may be used at either end of the central shaft.

The vacuum-cup model has inverted hemispherical cups attached to the top of a central shaft. (Fig. 134.) The cup mechanism moves around the shaft and at the same time up and down in the tub, forcing the water through the clothes in an action similar to that obtained with the hand "stomper."

The cylinder type has a perforated cylinder of wood, metal, or porcelain enamel which, in the conventional washer, revolves several times (commonly four to seven) in one direction and then in the reverse direction, inside an outer tub that holds the water. (Fig. 135.) In the automatic washer the cylinder may revolve in a single direction. Three or four projections or baffles on the inside of the cylinder catch the clothes, lift them from the water, and permit them to drop back into the water again. At the same time the wash water is forced in and out of the perforations, causing considerable agitation.

Some agitators may be run at two or three different speeds, adapted to washing different kinds of fabrics. Other washers have an automatic control that may be set to wash different materials different

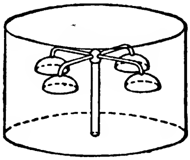


FIG. 134. Vacuum cup.

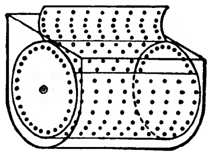
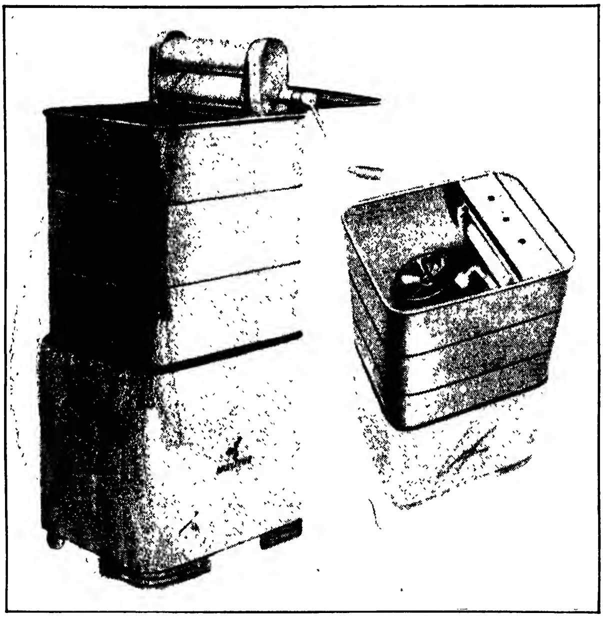


FIG. 135. Cylinder.

lengths of time and will stop the motor when the period is up. The control may also be set at a special position for continuous action. The dial indicates the various materials commonly laundered: rayons, silks, fade colors, heavy work clothes, etc.



Monitor Equipment Corp.

FIG. 136. A small washer with an impeller in the side of the tub has proved efficient.

Small washers, sometimes called "personal" washers, are on the market, but the amount of material that they can wash at one time is so limited for the most part that they are an unsatisfactory substitute

for the full-sized washer. They are useful for the washing of babies' clothes and lingerie and are especially adapted for small kitchens. Many of them are rather noisy and not very efficient, but one square-tub model of stainless steel has a round impeller in the side of the tub that causes a rotary movement of the clothes and is very effective in dirt removal. This washer has a hand-operated wringer attachment that may be turned down into the tub when not needed. It holds 3 to 4 pounds of clothes. (Fig. 136.)

MATERIALS AND CONSTRUCTION OF WASHERS

Washers range in price from about $60 to $300 or more for the more elaborate models. Price depends upon the materials and workmanship. Quality and price generally go hand in hand.

The materials commonly used in the construction of the tub are aluminum and porcelain-enameled steel. A study made at the University of Nebraska on the relation of heat retention to kind of material and finish showed little difference in cooling rate. In no case was the cooling rate high enough to be of significance in the selection of a washing machine.

Aluminum is light in weight and durable but may discolor with strong soaps and alkaline water softeners used in hard-water regions. Many aluminum tubs, however, are now specially treated to resist all such discoloring.

Porcelain enamel on steel is widely used for moderately priced washers. It is attractive in appearance, rust resistant, and very easy to clean, but may chip unless handled with care. Exposed screw heads inside the tub are usually objectionable because of their tendency to rust or to catch the fabric.

Most washers have round tubs supported by a leg frame or are on a base that carries the legs. A rubber gasket between tub and base cushions the tub and reduces vibration and noise. The closer the legs extend to the top of the tub, the better braced is the tub and the more adequate the support. The legs should be fitted with casters so that the machine may be easily moved from place to place. A compact machine, light in weight but rigid in construction, is desirable. In a few models the tub is housed in a square or round cabinet that sits flat on the floor. Several models have double tubs that tend to prevent the wash water from cooling too rapidly. Manufacturers are giving more attention to tub design so that there may be more interaction between agitator and tub in producing more efficient cleaning action. Sides are corrugated or indented with vertical

troughs, which create additional water currents, increasing dirt removal. Sometimes the bottom of the tub is cone-shaped or rounded like a bowl, with a sediment trap beneath the agitator. (Fig. 137.) Such a construction hinders dirt from circulating back into the clothes. If the sediment is drawn off through the drain pipe from time to time and fresh hot water added to the tub, the number of complete changes of water may be reduced.

Maytag Co.

FIG. 137. Sediment trap beneath agitator.

A washer of adjustable height is recommended. The lid is usually separate, but at least one washer has it attached.

Protective device

Washing machines may be driven by hand power, gas engine, or electric motor. The motor on household washers is usually ⅓ or ¼ horsepower and is connected to the mechanism by shaft or gears. The motor, cushioned on springs or rubber shock absorbers to minimize vibration, is placed beneath the tub to shield it from water and is either grounded or insulated from the metal framework of the machine. All moving parts should be enclosed, as a protection to children and to the worker herself. The electric cord is rubber covered. A switch independent of the gear switch is a convenience in starting the motor; such a switch should automatically protect from overloading by shutting off the motor the instant an overload occurs and so prevent the blowing of a fuse.

Part of the discussion already covered relates primarily to the conventional washer. Information in the following paragraphs on controls, wringers, centrifugal driers, etc., also deals with this type of washer. The automatic washer will be discussed in a later section.

The lever for controlling the agitating mechanism may be of several different types. The automobile-type shifter lever is found on a number of washers.

Wringers

After the washing process is completed, the water may be extracted by any of several different methods. The wringer is the most com-

monly used extractor. Rolls are made of soft or semisoft rubber, or the wringer may have one hard and one soft roll. Tests on wringers with different kinds of rubber rolls have shown that a maximum extraction of water of about 32 per cent occurs with all types of rolls regardless of the pressure, so that, although it is not possible to obtain the degree of compression with soft rubber rolls that is obtainable with hard rubber, apparently a high degree of compression is not necessary. There is a larger area of contact between soft rolls, which may compensate, partially at least, for the lower pressure. Soft rolls cause less injury to the clothing; buttons are not as easily removed or broken, for the roll adapts itself to irregularities in the fabric; creasing is less evident, and ironing, therefore, is easier. It is true that clothing seems to cling more readily to the soft rubber. The semisoft rolls have the good qualities of both soft and hard rubber; hard rubber stands up under the strain of use, and soft conforms to the variations in thickness of material being wrung.

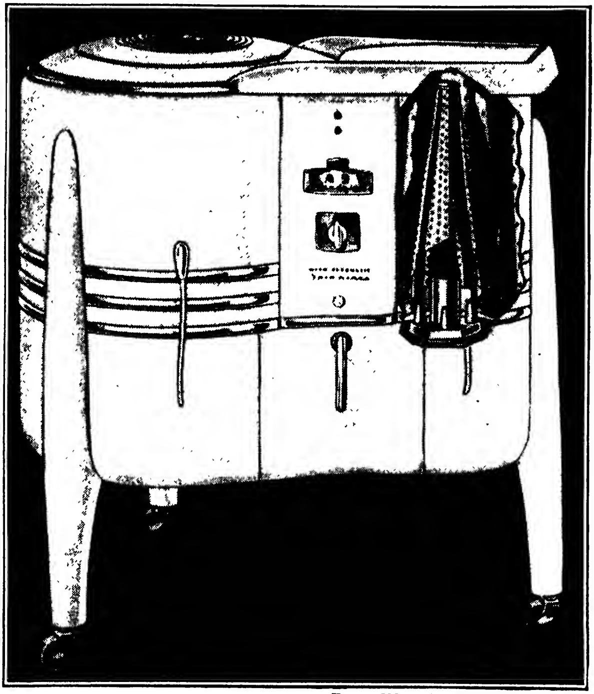
Several machines have a wringer equipped with a pressure selector, which permits choosing the correct pressure for any material from a sheer handkerchief to a heavy blanket. It is an advantage to have the tension on the rolls vary automatically.

The wringer controls should be within easy reach from any position at the machine. A centrally located safety release, easily manipulated and instantaneous in action, is essential. The wringer usually swings into and locks in at least four different positions, and frequently into eight positions. The direction of the rotation of the rolls and of the tilt of the drainboard is reversible. The drainboard should be of rust-resisting material and have rounded corners to prevent the catching or snagging of clothing; it should be wide enough to direct the passage of the clothes but not so wide as to interfere with them.

Centrifugal driers

Some machines are made with a centrifugal drier instead of a wringer. (Fig. 138.) The drier may be a removable basket attached to the central shaft within the washer tub, or it may occupy a separate tank beside the tub. In some models the drier is a perforated basket or cylinder; in others, a smooth-surfaced conical container with the openings only around the top rim. Since the number of revolutions per minute is high, the cover to the drier chamber must be fitted with a locking device to prevent its opening during the whirling process, if the container is of such a shape that it would tend to rise out of the chamber while it is spinning.

The drier may be whirling while a second tub of clothes is being washed, and in some models rinsing may be done in the centrifugal basket. The drier does not remove buttons and is a satisfactory way to extract the water from filled comforters, pillows, and blankets, leaving a soft, fluffy product. If desired, the whirling may be continued



Easy Washing Machine Corp.

FIG. 138. Washer with centrifugal drier. May be used for rinsing.

until a large percentage of the water is removed. On the other hand, the clothing must be entirely lifted from the tub into the basket, and, if the material is very bulky and heavy, this is difficult; a wringer helps in the lifting of the material. Clothes must be packed evenly into the basket, or considerable vibration occurs. There is no danger of catching the fingers in the drier.

SPACE REQUIREMENTS

Conventional washers are 21⅞, 23, 26½, and 29 inches in diameter. The square tubs require a space approximately 23 by 27 inches, and the washer with the spin drier, 23 by 36 inches.

Filling the tub

The tub should be filled with the least possible expenditure of energy by means of a hose attached to the faucet. A mixing hose fastened to both hot- and cold-water faucets is a convenience. A pail of water weighs 15 to 20 pounds, and, since it takes 6 to 8 pails to fill a tub, much energy is unnecessarily expended if the tub is filled in this way.

Emptying the tub

The tub is usually so constructed that it will drain quickly and completely when a good-sized pipe is provided. The opening to the drain pipe is frequently under the agitator. A threaded valve permits the tub to be connected to a piece of flexible hose, but, if it can stand in a permanent position, it may be connected to the sewer pipe. When no floor drain is available the tub may be emptied by an ejector, a two-armed hose, one arm of which is connected to a faucet so that it works by suction; but this method is not successful unless there is good water pressure. Many washers now have a water-discharge pump run by the motor, which empties the tub mechanically. In fact, a pump is available with practically all models and is well worth any additional cost. The curved end of the hose is hooked over the edge of stationary tub or sink, and all further effort on the part of the operator is eliminated.

Washing process

Before the washing process is started, clothes are sorted according to fabric, color, and amount of dirt. Stains are removed and, if possible, rents and tears mended. The washer is filled to the water line with warm water (120° to 125° F.) if the clothes have not been soaked, and, if previously soaked, with somewhat hotter water (150° to 160° F.). / (Fig. 139.) Potter of Virginia Polytechnic Institute reports that 160° F. water gives best cleaning results. Research at the Ellen H. Richards Institute, The Pennsylvania State College, confirms this conclusion. White cottons and linens comprise approximately 80 per cent of the home wash, and soil removal and whiteness retention in these fabrics have been found to increase in almost direct proportion to increase in the temperature of the water. A loss of 10° to 15° may be expected from the cooling effect of the clothes and washer, especially if the clothes have been soaked, so that the actual

washing temperature will be from 145° to 150° F. Soaking is recommended, however, because it opens the meshes of the fabric, loosening and dissolving part of the dirt, and so permits the use of hotter wash water. Soaking also prevents the setting of any stain that has been overlooked. Some housewives wish to avoid the extra labor of soaking and use a second suds instead.

In either case, before the clothes are put in, the soap shavings or chips are added to the water and the washer operated until good thick suds are obtained. If the water is hard and clothes are put

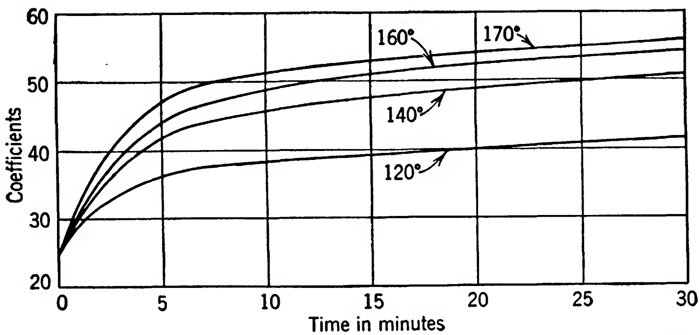


FIG. 139. Comparative soil removal when washing was done at four different temperatures.

into the tub before the soap is added, the hard-water curd will form inside the meshes of the cloth instead of on the surface. Since such curds are insoluble, they are removed with difficulty and tend to harm both texture and color.

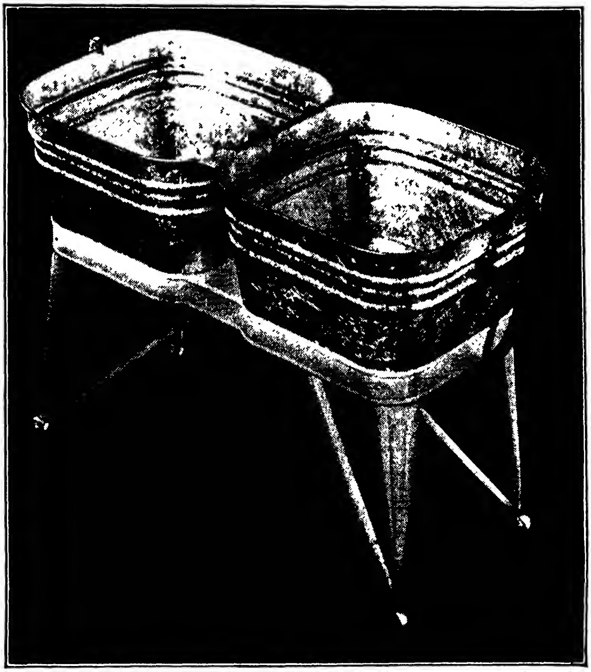
The clothes are added gradually so long as free water action is obtained. A greater quantity of small pieces may be added than of large ones. Overloading hinders agitation and lessens the proportion of water. Tests show that underloading also is not desirable. "A possible explanation is that underloading provides too little friction between clothes, and between water and clothes."[1]

The length of the washing period will depend in part upon the nature and amount of dirt. Slightly soiled clothing requires only a short washing period. Silks and woolens should be washed more rapidly than cottons. Loosely woven materials wash more quickly than those of fine close weaves. Some agitator washers have a variable speed control; fine fabrics may be washed at the low speed. In

[1] E. B. Snyder and M. P. Brunig, *A Study of Washing Machines*, p. 32.

machines of one speed, the agitator usually rotates at a medium rate, and the washing period is shortened or lengthened as required.

At the end of the washing period the wash water is removed with the type of extractor provided on the machine, and the clothes are rinsed. If the clothes have been washed in lukewarm water, the first rinse is of hotter water (140° F.), to aid in the removal of soap and



One-Minute Washer Co.

FIG. 140. Movable tubs are useful for rinsing.

any remaining soil held in the meshes of the cloth. Some investigators advise against too high a temperature for the rinse water. On the other hand, too low a temperature, less than 100° F., has been found to cause the yarns of the cloth to shrink, holding in the soap and soil. The hot rinse may be followed by a cold rinse, and bluing if desired, except for silks and woolens for which moderately warm water is used in the washing process and all rinses.

When no stationary tubs are available and it is not convenient to use the washer for rinsing, movable tubs like those illustrated in Fig. 140 are useful. They are of corrosion-resistant material and have free-wheeling casters for ease in shifting from place to place. They

may be emptied without being moved. When a rinse in the washer is possible, it is recommended, since such a rinse is two or three times as effective as the hand rinse.

Care of washer

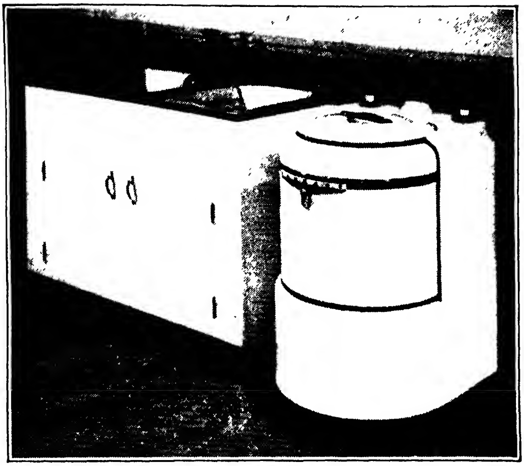
When the washing is finished, the tub should be drained immediately. Fresh water is then added and the motor operated until the tub and cylinder, vacuum cups, or agitator are thoroughly rinsed. The agitating device is removed and wiped clean and dry, and the tub is dried before the unit is replaced. The agitator is often left lying free in the tub until the next time of use. Remove lint from the drain pipe. Do not scour the tub with harsh abrasives to remove any deposit from hard water; such scouring will tend to roughen the finish and make it more difficult to keep it in condition. A cloth dipped in vinegar water will often remove a water coating. Wipe the wringer rolls with a damp cloth and release the pressure. Leave the washer cover slightly ajar to prevent the development of musty odors. The water discharge hose should be lowered and drained completely; otherwise the rubber tubing will gradually deteriorate.

Carefully follow manufacturer's directions for oiling, both as to kind of oil and frequency of application. If the washer is stored in a cold room in winter, the grease in the mechanism may harden. The washer should then be allowed to become warm before the motor is started. Different types of motors require different kinds of care, but unless the motor parts are sealed, some care is essential. The life of the machine depends to a large extent upon the intelligent use and care that it receives.

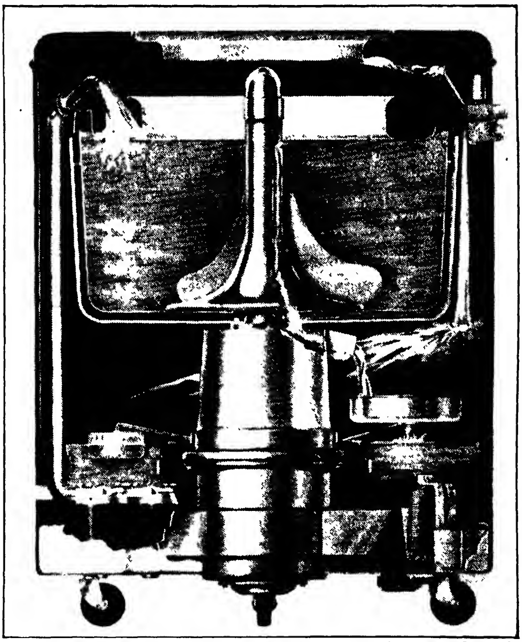
Automatic washers

Although some automatic washers were manufactured before the recent war, a number of additional automatic models and also the semiautomatic type are now available and various other companies have such styles in different stages of test and readiness for placing on the market.

Both the automatic and semiautomatic types wash, rinse, and damp-dry the clothes ready for the clothesline or indoor drier, without the hands touching them. Wash and rinse waters are usually changed with each load, but at least two companies permit the homemaker to reuse the rinse water for soaking or washing of the next load, and one washer can expel the suds into a laundry tray and later return it for another load. (Fig. 141.)



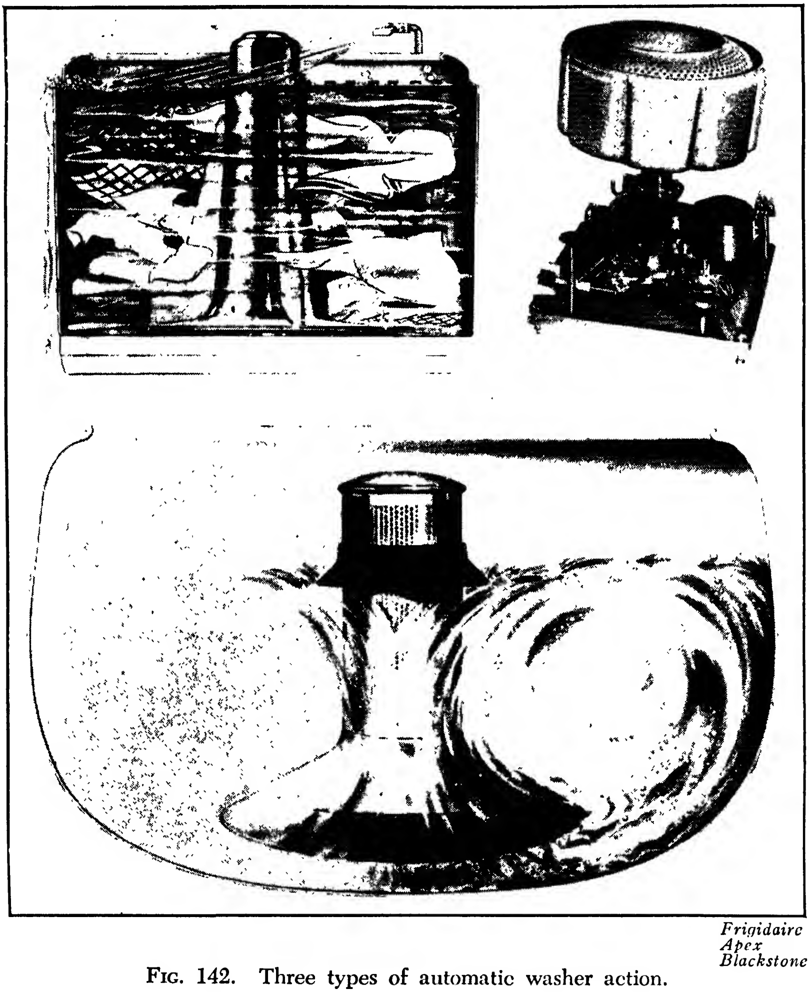
(*a*) *Sears, Roebuck & Co.*



(*b*) *General Electric*

FIG. 141. (*a*) This automatic washer provides for saving the suds for the following load and later returning them to the washer. Both actions are controlled by switch positions and require no effort on the part of the operator. (*b*) Another automatic washer saves the rinse water which may be used for the following soak period or for subsequent wash water.

Water action is brought about by an agitator, a rotating perforated cylinder, a "bouncing" basketlike tub, or a pulsating mechanism. (Fig. 142.) The washer may be loaded from the top or the side.



Frigidaire
Apex
Blackstone

FIG. 142. Three types of automatic washer action.

When loading is done from the top it is usually possible to stop the operation at any point in the cycle and add additional clothing or remove some piece from the load. Some washers have an automatic cutoff switch that stops all movement as soon as the lid is lifted. In the strictly automatic washer, temperature of the water and the various cycles from soaking to damp-dry spin are automatically con-

trolled. Water for washing may be hot or warm. The hot water is of the temperature provided by the homemaker's hot-water tank; the warm water is thermostatically regulated for 100° F. by a mixing of hot water with sufficient cold. The water for rinsing is always warm (100° F.). Some manufacturers of automatic washers recommend final rinses in cold water to save the supply of hot water. Further research is needed to establish the desirability of this procedure. The water is extracted by a spinning action, which varies in the different makes from about 300 to approximately 1100 revolutions per minute. There is some evidence that faster spinning causes a greater deposit of lint. Sediment traps may be provided, and a filter screen is frequently used to prevent any lint from getting into the waste pipes and clogging them.

The semiautomatic washer requires that the operator turn the faucet for filling the tub and regulate the controls for length of wash and rinse periods. Hands need not touch the clothes, however, from the time they are placed in the washer until they are removed after the damp-dry spin. Connection to a mixing faucet allows use of water of any desired temperature, and hot water may be used for one or more rinses if preferred to the warm water provided in the automatic washer. As a result of his investigations, Potter recommends that the temperature of the rinse water be nearly as high as the temperature of the original wash water, particularly for the first rinse.

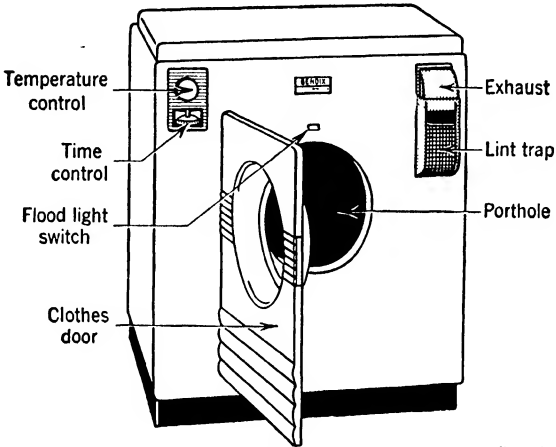
The manufacturers of certain automatic washers advise that they be bolted to the floor to prevent excessive vibration or a tendency for the washer to skid around during operation. Many of the top-opening models are supplied with a device that automatically compensates for any unbalanced load in the tub, so that permanent installation is not necessary. Most of these washers have some type of leveling screw for adjustment on uneven floors. A $\frac{1}{3}$-horsepower motor is commonly used.

Automatic and semiautomatic washers are almost square in shape. Dimensions of available models were 24 by $26\frac{3}{4}$ inches, 23 by 26 inches, 28 inches square, and $27\frac{1}{2}$ by 29 inches.

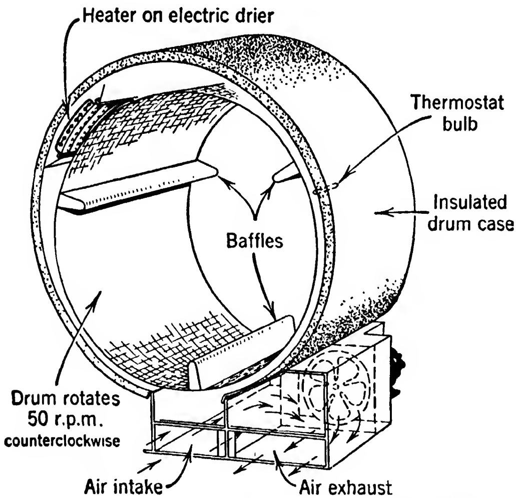
Driers

Indoor automatic driers or dryers (the word is spelled both ways) may be used in the home with great convenience. They eliminate the need of yard space for hanging clothes and are independent of weather conditions. They may be operated to dry one load of clothes while another is being washed. When the clothes are sufficiently

dried, they may be ironed immediately without the necessity of sprinkling. All the processes for obtaining clean household linens and



(*a*) *Bendix*



(*b*) *Hamilton Mfg. Co.*

FIG. 143. (*a*) Automatic drier—outside view. (*b*) Automatic drier—cutaway view.

personal clothing are thus greatly speeded up, and much time and energy are conserved.

The automatic drier is similar in external appearance to a number of automatic washers. (Fig. 143.) The drier is usually 31 inches

wide and 25 to 27 inches deep. It is loaded through an opening on the front panel, which in one model is built on a slant. The rotating drum may be entirely of woven wire or may have only the ends or the cylinder sides of the wire screening. In either type the finish is very smooth to protect the clothes. In some models a series of baffles aid in tumbling the clothes around for faster drying. Air, heated either by gas or electricity, depending upon the model, is forced through the cylinder and is then exhausted through a lint trap into the room. The lint trap should be cleaned at regular intervals. A ¼-horsepower motor is commonly used to rotate the cylinder and drive the blower or fan. Most electric driers are designed for use on 230-volt circuits, since the heater is rated at 4000 to 4600 watts. A 1500-watt 115-volt drier is also available, but usually low-wattage driers are slow and therefore expensive to operate. The gas-heated drier is used on the 115-volt circuit, since the electrical connection is only for operation of the fan and the light.

Drying time varies with type of clothing and degree of dryness desired. Most driers require from 30 to 35 minutes to damp-dry a load of clothes and from 45 minutes to an hour for complete drying. Since the drum revolves slowly, approximately 50 r.p.m., the door may be opened without stopping the motor and the clothing examined and pieces which have dried sufficiently may be removed. An internal light is installed for ease in inspecting the condition of the load. In normal use the drum will continue to revolve for 5 minutes after the heat is automatically shut off. This allows the clothing to cool somewhat before it needs to be handled.

A drier exhausts a fairly large amount of warm, humid air into the room where it is installed. Adequate ventilation should, therefore, be provided. Sometimes it is necessary only to open one or two windows; otherwise a 8- or 10-inch ventilating fan may be used.

Although the temperature in most driers is approximately 190° F., during prolonged periods of heating it may rise to 210° F. or even 220° F. Most manufacturers recommend, therefore, that 100 per cent woolens, nylons, and certain rayons should not be dried in this way.

IRONS AND IRONERS

Probably our long-ago ancestors were so glad to have clean clothes that wrinkles passed unnoticed. A similar feeling animates the present-day housewife when the choice is between a few wrinkles and several hours of hard work over the ironing board. The new electric

irons and especially the motor-driven ironer have greatly reduced the time and energy required for ironing.

The first irons were undoubtedly stones. Ancient Romans used wooden mallets but even at a very early date devised a kind of press in which the clothing was smoothed beneath a weighted cover. Later the cover was screwed down to increase the pressure.

In Scotland in the tenth century a linen smoother of black glass was used. It was brought to the country by the Vikings and resembled a large inverted mushroom. A hundred years later, heated irons were used in France, the heat being produced by charcoal or a small hot iron bar placed on a shelf inside the iron.

Two hundred years ago in England clothes were laid on a table, over which a rock-filled cylinder was rolled, a cylinder so heavy that it had to be operated by two men. In Benjamin Franklin's diary there is a reference to his visit to the home of George Washington to see an ironer, which is not described but which was undoubtedly of this type.

Later still the wooden ironer came into use, a roller that was moved back and forth across a flat board. These hand ironers were often beautifully carved by young men who presented them to their brides for wedding gifts. Following this type came the ironer with two rolls, manipulated like a wringer, the immediate predecessor of the present-day ironing machine.

At the same time, the hand iron was evolving from the sad iron, in one piece or with a detachable handle, to the gas, gasoline, and electric iron. The first electric iron was without a shiny finish and did not have a heat-resisting handle, so that a holder was needed to protect the hand. Only since 1915 has the convenient modern electric iron been available, and even now improvements are added from year to year.

TYPES OF IRONS

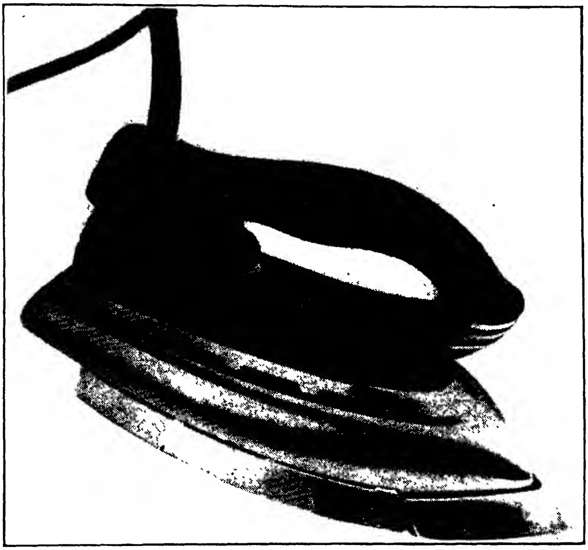
Irons vary considerably in price, depending upon the type of element and surface finish. The least expensive have a coiled wire element placed in the grooves of a porcelain insulating brick. These coils wear out comparatively soon under frequent heating and cooling. The soleplate is somewhat small in area and not very thick, with only a thin metal coating over the casting, which does not take a very high polish.

Medium-priced irons have a metal ribbon element wound on mica sheets; they often carry a 3- to 5-year guarantee but usually last longer. In the highest-priced models the wire element is embedded in the insulating material and may carry a lifetime guarantee. The

soleplate casting is, as far as possible, without flaw, giving a smooth flat surface, and the iron is heavily plated and highly polished. Several new irons have an aluminum soleplate. In all irons the heating element must be insulated from the metal body to prevent the operator from receiving a shock.

Characteristics of a good iron

A good iron has tapering sides with beveled edges and a narrow point to get around buttons and into gathers. Some have a special



Yale and Towne

Fig. 144. The TipToe iron for ironing gathers, ruffles, etc.

indentation on the side of the sole for ironing under button edges. If the iron is well balanced, the point will not dig into the material. One iron has a divided soleplate, which permits separate use of the toe whenever a small iron is needed to iron ruffles and gathers. This toe is about one-fifth of the total area of the soleplate and is heated by a separate heating element. The entire soleplate is used as in any iron, but, when desired, a slight twist of the wrist lifts the back four-fifths of the iron, leaving the toe free for a special ironing operation. (Fig. 144.)

The iron handle should be of a size and shape comfortable for the hand, of heat-resistant material, and far enough away from the body of the iron to eliminate any danger of burns. A properly constructed iron should be insulated so that the heat will be concentrated in the

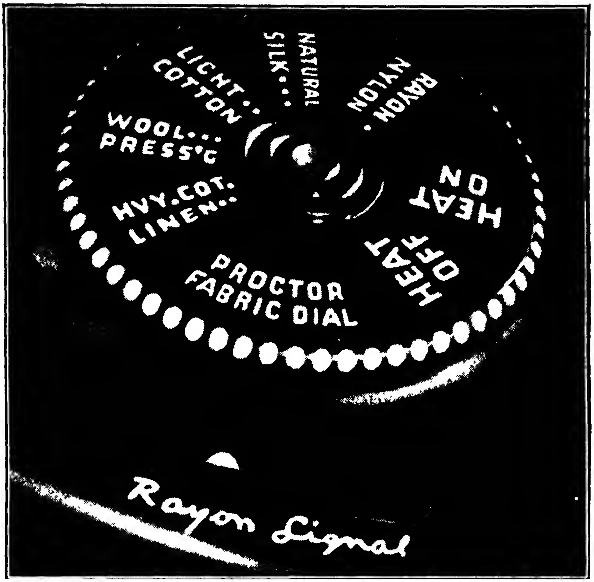
soleplate and the upper surface remain cool, but, when used for a long time at the highest temperature, even the thermostatically controlled iron becomes fairly hot all over. In one iron the plastic of the handle is extended over the entire top surface to act as an insulator against the heat, and in another the top surface is separated from the main body of the iron by a narrow space through which air circulates to cool the top. According to the proposed American Standards Association standards for electric flatirons, the temperature of the handle must not exceed 150° F. and the temperature of the adjusting lever must not exceed 200° F. Occasionally a thumb rest is molded into one side of the handle.

Formerly the standard household iron weighed about 6 pounds, but 1000-watt irons, weighing only 3 to 4½ pounds, with automatic heat control, are steadily gaining in favor. When the lightweight iron is used in ironing heavy materials, the fabric should be properly dampened or the operator will need to exert a good deal of pressure to remove creases. Very damp fabrics usually require a somewhat longer ironing period, although the high power tends to speed up the process. In extensive tests made by Potter at Virginia Polytechnic Institute, best ironing results were obtained when a material was dampened to the optimum moisture content, found to average about 35 per cent. This percentage of moisture was obtained most satisfactorily by wetting the fabrics and drying them to the required dampness.

Heat control

Irons may or may not have an automatic heat control connected to the soleplate, which shuts the electricity off above a certain temperature and turns it on again as the iron cools. Most automatic controls have a range of heats suitable for different types of materials, with the scale marked high, medium, and low heat, and off, or with the names of the fabrics, such as silk, wool, cotton, and linen, and in some cases indicating a range of temperatures for each fabric. The last type is preferable, since such heats have been determined as a result of testing and guesswork on the part of the operator is eliminated. (Fig. 145.) A control reduces the kilowatthour consumption by supplying only the heat needed; it eliminates fire hazard, since the iron cannot reach an excessively high temperature, and greatly lessens the wear on the heating element. Overheating is very detrimental to an element. A difference of not more than 80° F. between the "on" and the "off" of the control is recommended, and in some irons the heat is controlled within much narrower limits. If the iron does not have an automatic control, it is an advantage to have a switch on the cord or in the iron

plug by which the heat may be turned on and off without disconnecting. Irons should heat evenly, that is, without any noticeably cold or hot spots. The point is often somewhat hotter than the rest of the iron, the heat gradually lessening toward the heel, which is coolest.



Proctor Electric Co.

FIG. 145. Fabric dial with nylon setting. New dual thermostat permits a rayon safety signal that points to green when it is safe to iron nylons and rayons and to red when temperature is too hot.

Temperatures suitable for different fabrics

Linens and cottons require a fairly high temperature, silk and woolen materials a comparatively low one. Viscose rayons and unweighted silks use a heat suitable for wool, but weighted silks and especially Celanese rayon require even lower temperatures. Celanese is melted by a hot iron. Potter found that correct temperatures for ironing linen ranged from 375° to 425° F.; for cotton, 325° to 375° F.; and for rayon, 275° to 325° F.

Cords

Cords used with irons must have an insulation of asbestos beneath the fabric covering. They are flexible and sometimes tend to kink, a difficulty avoided by the use of a rubber-covered cord. A wire spring attached to the plug holds the cord away from the iron, and there are

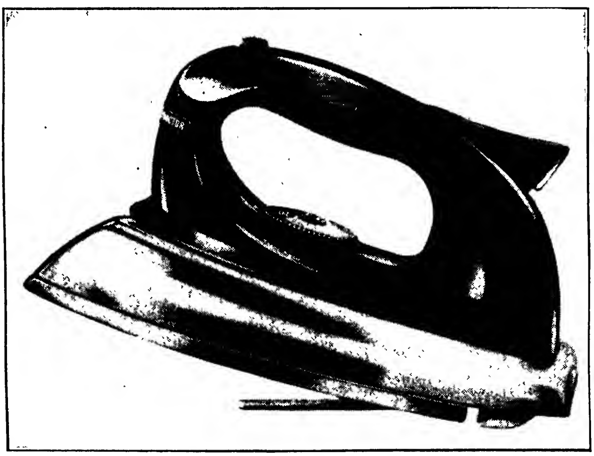
attachments for the end of the board which will keep the cord away from the clothing. One type of cord uncoils or coils automatically as the iron is pushed back and forth. The iron and wall plugs should be easily removable without pulling on the cord. The present tendency is to have the cord again permanently attached to the iron but on the side rather than at the back, a position that lessens contact with the clothes. Some cords are reversible and may be turned to either side, depending on whether the operator is right- or left-handed. Cords should not touch the iron when it is hot. After the iron has cooled completely an attached cord may be wound loosely around the iron for storage.

One iron is cordless. While the position of the garment is changed, the iron is placed on a stand that is heated by an electric element embedded in it. A rapid worker sometimes finds that the interval during which the iron is on the stand is not sufficient to bring it to the desired temperature.

It is preferable to connect the iron to a service outlet since it is rated at the least at 600 watts, unless a 660-watt light socket is available. One-thousand-watt irons should never be attached to light sockets.

Heel rest

With the exception of certain steam irons, the electric iron has an attached rest, usually at the heel, although one model is turned on the side. It requires less energy to tip the iron onto the heel or side than



Proctor Electric Co.

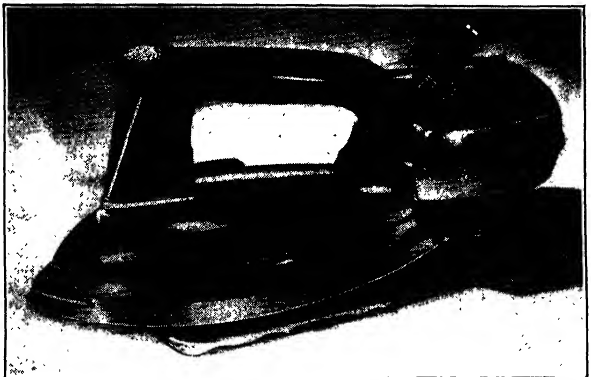
FIG. 146. An iron that lifts itself with a single leg for greater soleplate ironing surface.

to lift it to a raised stand. The soleplate of one iron is raised at an angle by a well-placed switch and is easily snapped back into operating position. (Fig. 146.)

An iron should be kept clean, the soleplate free from rough places, stains, and rust.

STEAM IRONS

Steam irons may be constructed for that use alone or may be combination irons, for use either as steam or dry irons. Unless the steam is



General Mills

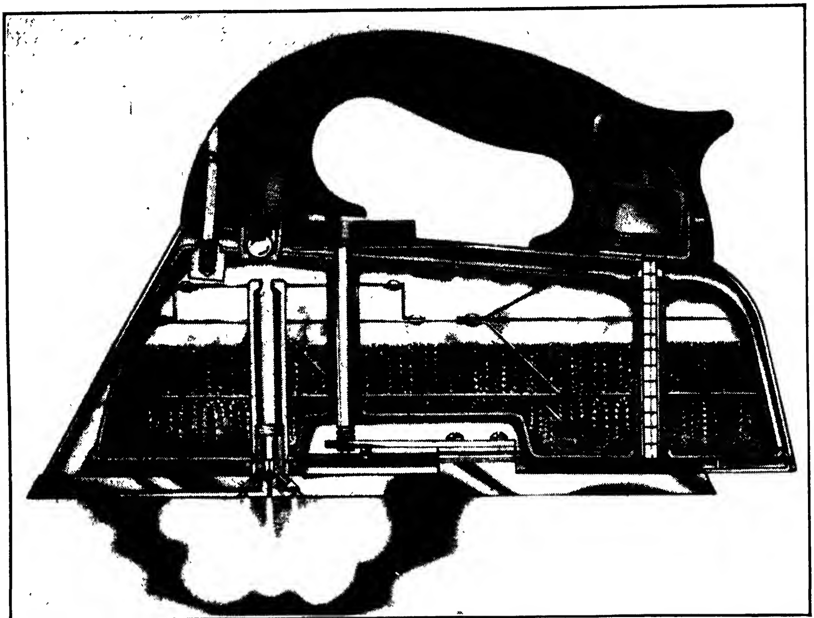
FIG. 147. This iron has a separate steam attachment that can be used when needed.

to be used frequently the dual-purpose iron is probably the most satisfactory buy. One manufacturer offers a separate steam attachment, to which the iron is quickly and easily connected if necessary. (Fig. 147.) In this attachment the water reservoir is at the back and may be filled at any time in the ironing process without the escape of steam, because the steam is generated only in the soleplate. In most irons the water cavity is above the soleplate. (Fig. 148.) The cavity holds from 1 to 2 cups of water and is filled through an opening on the side of the iron or behind the steam-control knob at the front of the handle. The steam issues from openings located at the point, around the edge of the sole, or near the center of the sole, from which it is spread over the surface by a series of radiating channels. The fabric is moistened as it is pressed.

Most steam irons are thermostatically controlled, with the names of the fabrics indicated. As a result of tests on combination irons, Breckenridge concluded that steam irons are desirable for the ironing

of woolens and certain rayons but a dry iron is more acceptable for cottons, linens, silks, nylons, and other rayons, because more moisture than the steam iron provides is required for these materials. The difficulty may be partly overcome by light sprinkling of the fabrics before ironing. Starched pieces should always be predampened.

Soft water, either rain water or distilled water, is recommended for filling the iron. Hard water tends to form a lime deposit that



Fabric Master, Omar Appliance Mfg. Co.

FIG. 148. Cutaway view of steam iron.

gradually cakes the sides of the cavity and may close the steam vents. If hard water must be used, it is suggested that the reservoir be filled occasionally with distilled vinegar, allowed to steam for 15 minutes, and then left to stand overnight. In the morning the vinegar should be poured out and the cavity thoroughly rinsed with water.

Before the soleplate is thoroughly broken in, the steam iron may tend to spit water when first used. This will cease with longer use.

IRONING BOARD

The hand iron is used with an ironing board. The board has also developed; at first a table top covered temporarily with a blanket and sheet, then a shaped board placed across the flat tops of two chairs or

between a table and a chair (a type still in use in many homes), now often a collapsible board or one that folds into a shallow wall compartment. A built-in ironing board should be placed so that the shadow of the worker will not fall on the board. Folding boards should have a well-supported framework to prevent swaying. The board is about 54 inches long, with one end narrow enough to permit double clothing to be slipped on and off. The height is often adjustable and should be fitted to the individual; if stationary, approximately 34 inches is a good average. As a result of research on the effect of height of ironing surface on the worker, Knowles found that most homemakers preferred a board 34 inches from the floor. A board 20 inches wide was also recommended for ironing of flat work, men's shirts, etc. It can be constructed of ¾-inch plywood and attached to the regular ironing board by means of wooden buttons fastened to cleats on the underside of the regular board.

The ironing board is padded to allow a certain amount of "give" under the pressure of the iron; this increases the ease of ironing. The outer cover, frequently of unbleached sheeting, should be removable for washing. It may be fastened onto the board in any of several ways: by tapes across the back of the board, by a drawstring run through a hem, or by metal grips that catch into the edges of the cover and hold it tightly in place.

Covers are also made of asbestos and Fiberglas. They are soft and smooth, and the iron moves over them easily. They will not burn and need only an occasional washing. The Fiberglas can be wiped with a damp cloth without removing it from the board. With care, covers of these materials will wear a long time.

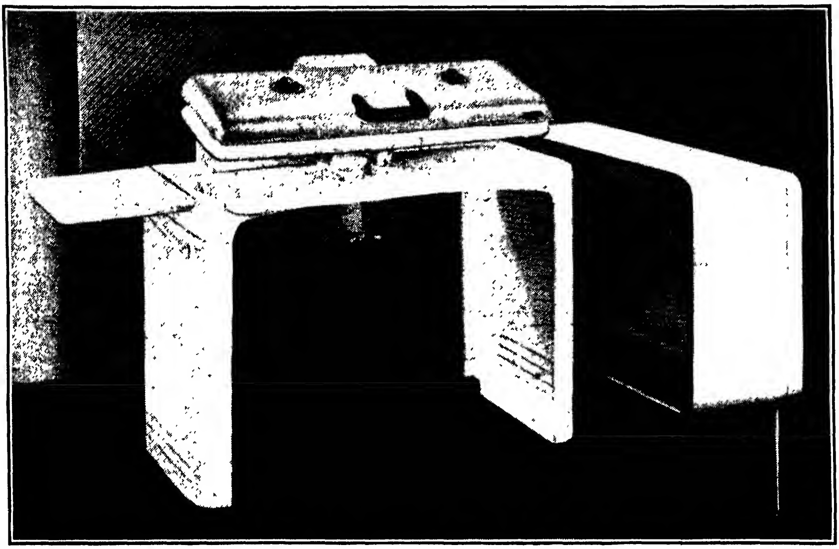
Ironers

Ironers may be classified in several different ways, but the main division is into the roll and flatplate types. (Fig. 149.) Each type has certain advantages, and the choice will depend upon the individual. The roll requires fewer manipulations, but the inexperienced worker usually finds it easier to iron shirts, dresses, and similar clothing on the flatplate. The roll or flat surface corresponds to the ironing board. It varies in length from 24 or 26 inches to 32 inches or more.

The roll may have closed ends because of the manner in which it is attached to the framework, or both ends may be open with a support in the center; but most frequently only the left end is open, the right being fastened to the gear case. Flat work is ironed satisfactorily on

any type of roll; double clothing, however, is more easily handled on a roll with an open end over which the garments may be slipped. The roll revolves during the ironing process, carrying the clothing through the machine.

The roll or board is evenly padded and covered with a muslin cloth to give a smooth, resilient surface. When the padding becomes packed down, the surface is too hard; the padding should, therefore, be re-

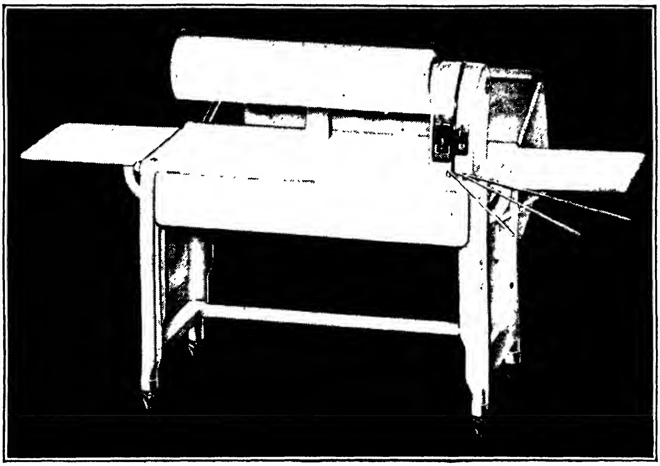


General Electric

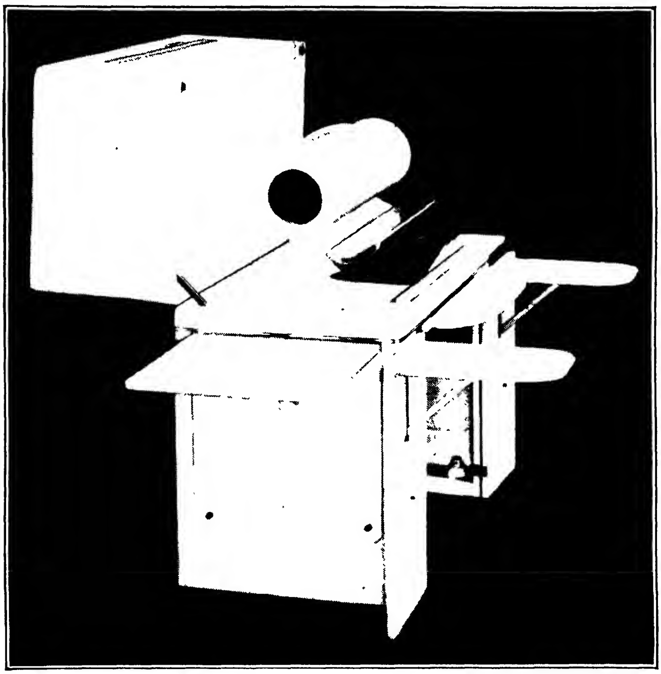
FIG. 149. Flatplate type of ironer.

moved occasionally and fluffed up or reversed in position, or new padding may be added. When the muslin cover is soiled, it should be laundered.

The ironing surface, a metal strip containing the heating element, called the shoe, is made of aluminum, cast iron, steel, or a metal alloy. It may be flat or concave, depending upon the type and model. The shoe may be located above the roll or beneath it. (Fig. 150.) The shoe is usually heated by electricity, thermostatically controlled, with separate heating elements at either end. It is an added advantage if a range of heats is available. Various ironers feature such a control, calibrated in the same way as the hand iron, for ironing rayon, silk, wool, cotton, and linen. Either end may be used independently of the other, and each may be heated to a different temperature if desired.



Barlow and Seelig



Bendix

Fig. 150. Roll-type ironers. Shoe above and below roll.

When the shoe is beneath the roll, a forming board is attached to its front edge for ease in arranging the material to be ironed. This underneath position of the shoe makes possible the construction of ironing points at each end of the shoe for ironing into hard-to-reach places, such as tucks, gathers, and ruffles. In one ironer the shoe is brought to a full-open position by pulling the forming board toward the operator. (Fig. 150.) In models where the shoe is above the roll, the shoe may be tipped back to a full-open position. This position is useful for steaming velvets, neckties, etc., and also for cleaning the shoe. The shoe must be brought back into place before the mechanical controls will function. Either shoe or roll may move to make contact with the other.

In the flatplate type, the shoe is drawn toward the operator as far as possible, and immediately the buck or board is automatically forced up against the shoe. At the end of the period of contact a slight push on the handle breaks the circuit, allowing the buck to slide back to the lower position again.

The shoe is smoothly finished and corrosion resistant and must be kept clean. Any starch sticking to it may be wiped off with a damp towel or gently removed with a piece of emery cloth. An occasional rubbing with paraffin or beeswax when the shoe is warm will help to keep the surface smooth.

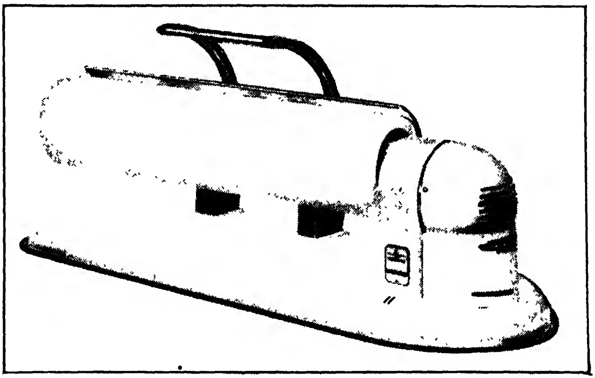
The switches for the motor and for heating the shoe and the controls for the roll should be conveniently located where they are easily accessible. The roller controls are operated by finger tip, hand, knee, or foot. A safety release, usually manually operated, separates the shoe and roll if the current accidentally ceases to flow while the ironer is in operation.

The ironer has a flat tablelike surface below the press board or roll to hold fabrics as they are ironed, so that they will not get wrinkled or soiled. This surface should extend several inches beyond the roll or board. An attached rack or table top for holding ironed pieces is a useful addition.

Ironers may be purchased in various forms. Perhaps the most common type has the roll attached to a permanent framework base with the legs fitted with casters so that it may be easily moved around. Some have a hinged table top which provides additional work surface when the ironer is not in use. When storage space is limited, purchase an ironer that folds on end and rolls into a corner or closet. One model tilts out of its own vertical cabinet for use, the cabinet occupying no more floor space than that taken by a kitchen chair.

The portable ironer is similar in construction to the larger ironer. It is of the roll type, with the controls manipulated by hand, arm, or knee. It may be used on any table top and should be light in weight for ease in handling. (Fig. 151.)

An ironer is expected to give a smooth, dry, unscorched ironed product, with a glossy sheen or not, as desired. It should do this in the least time, with the least effort on the part of the worker, and at the smallest expense possible. Various factors contribute to this end. One of these factors is amount of pressure. The pressure exerted



Barlow and Seelig

FIG. 151. A portable ironer.

by the shoe on roll or board is usually about 200 pounds but may be as high as 400 pounds. The pressure should be uniform throughout, except at the extreme ends. This uniformity of pressure is difficult to secure in the roll-type ironer unless the shoe is supported with sufficient rigidity to maintain alignment with the roll at all times. The support of the shoe is a point that should be carefully checked in making selection.

The heating element of the ironer is commonly rated at 1320 watts; the motor is usually 1/6 horsepower. When ironer cabinets are closed they are about 36 or 37 inches wide and 18 or 19 inches deep. One cabinet, however, is 30 by 18 inches and another 34 by 18½ inches. When open, with shelves raised into position, they may measure as much as 65 inches in width and 43¼ inches in depth, although it is possible to obtain models that are somewhat smaller.

Amount of heat also influences the speed of the ironing operation. The shoe should be thoroughly heated before the ironing is started, but the motor need not run during this time, unless the same control

is used for both. Some ironers have a pilot light to indicate when the current is turned on. Warm the roll by rotating it against the shoe for some minutes before ironing. It is also well to allow the roll to rotate against the shoe between pieces, to keep it warm and to dry out any dampness. The roll usually makes about 6 revolutions per minute. On some models two or three speeds are obtainable, varying from 4 to 10 revolutions per minute. The faster speeds may be used for thin, the slow for heavy or extra damp materials, reducing the number of times a piece must be passed through the ironer. The slower rate may also aid the inexperienced operator to develop technique. Some ironers feature an oscillating movement of approximately 1-inch amplitude, which is similar to the back and forward motion of a hand iron. The pressing action requires no movement of either shoe or roll, but, when most ironers are used for pressing, the roll is held stationary and the shoe brought against it.

To maintain the evenly padded surface, distribute the ironing over the roll, using different parts of the roll for different pieces. This method will also utilize all the heat and prevent the scorching of the pad cover. Do not have the clothing too moist. Excessive moisture lowers the temperature of the shoe. Iron all articles dry to prevent wrinkling. Alternate flat work with more complicated pieces to maintain an even temperature. Turn buttons and hooks against the roll. During the ironing process, smooth the material on the roll from the center toward the ends.

Flat work is easily ironed even by a beginner. More complicated clothing requires experience that is only acquired, as in all other kinds of operations, by repetition. Do not attempt to iron on the mechanically run machine articles that may be ironed more quickly and more satisfactorily with the hand iron.

Oil the motor according to the manufacturer's directions.

Laundry room

It has been the custom to place the laundry room in the basement, but modern construction frequently locates it on the ground floor, near the kitchen, a place which eliminates much passing over stairs. Here natural lighting is better, and frequently the ventilation, so necessary for removing heat and steam, is improved.

The walls of the laundry should be light in color and moistureproof; the floor non-absorbent, resilient without being slippery, and easily cleaned. When a cement or wood floor must be used, put rubber or linoleum mats in front of the tubs and the washer. If the tubs are

placed at a right angle to the windows, better natural light is received. Artificial lights should be provided over the washing and ironing centers. Blue daylight lamps are especially recommended for the laundry room because they help the homemaker to see spots of dirt and stains on the clothing. They should be 150- or 200-watt lamps to provide sufficient light.

If no laundry room is available and the washing must be done in the kitchen, the clothes should be sorted elsewhere for sanitary reasons. Manufacturers of washers that are permanently connected to a hot-and-cold water supply and the drain suggest the bathroom as a suitable location for the machine. With electric outlets in every room, ironing may be done wherever it is most convenient. A cool, well-ventilated location is desirable. Use a chair or stool if possible, but, if it is necessary to stand, be sure a resilient mat is beneath the feet.

WATER HEATERS

Hot water is essential in the home for the protection of health. It is needed to insure clean hands, clean clothes, clean foods, and clean utensils. A water heater is, therefore, of primary importance.

Construction

Most water heaters have certain characteristics in common, regardless of the source of heat. They are made of galvanized iron or steel, copper-bearing steel, copper, stainless steel, Monel metal, or glass-lined steel. Galvanized tanks are subject to corrosion in certain water regions. To prevent this a rod of magnesium or magnesium alloy is inserted into the tank. Since magnesium is a more active metal than the inside zinc coating of a galvanized tank, the hot water reacts with the magnesium, corroding it instead of the zinc. Replacement of the rod is occasionally necessary. If water is very soft, the tank should be of copper and the connecting pipes of brass. Brass pipes should not be used with a galvanized tank, however, because of electrolytic action between the brass and the zinc, with resultant corrosion. Glass linings on metal keep the hot water free from rust and other impurities. Tanks are commonly finished on the outside with synthetic enamel.

A blanket of rock wool or Fiberglas, 1 to 3 inches thick, is used for insulation; the greater the thickness, the less loss of heat from the tank. A heat trap, in the form of an inverted L-shaped pipe at the top of the tank, prevents circulation of hot water to the house plumb-

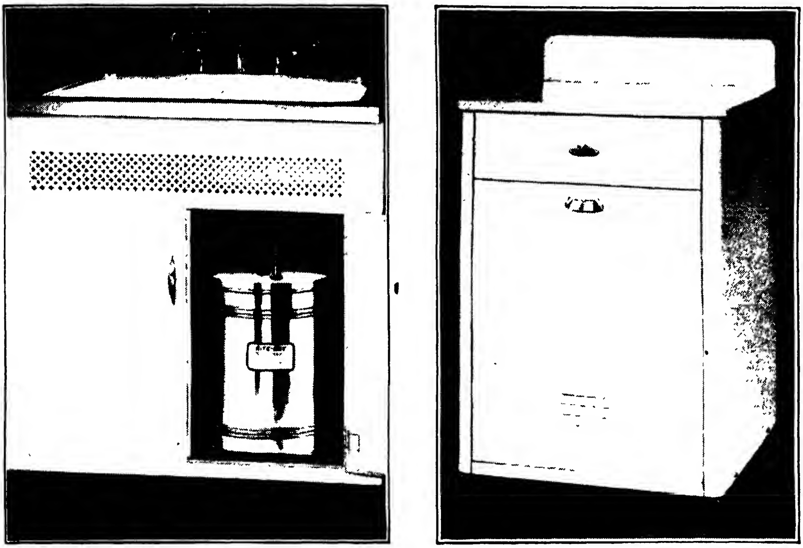
ing system by means of convection currents, when hot water is not being drawn. Temperature and pressure relief valves should be installed, so that, if the burner in the non-automatic types is accidentally left ignited or if anything goes wrong with the automatic appliance and steam is formed, it will blow off into the drain without danger of explosion. The relief valve is installed in the cold-water line adjacent to the heater, with no shutoff valve between it and the tank. A baffle above the cold-water inlet spreads the incoming water over the bottom of the tank and minimizes the mixing of cold water with the water that has already been heated.

Tanks are commonly of 30-gallon capacity, but DeForest, Iowa State College agricultural engineer who specializes in farm electricity, recommends a 50-gallon tank for the average family of four and an 80-gallon size if automatic washers are to be installed. DeForest estimates that each bath requires 5 to 10 gallons of hot water, a shower taking slightly less. Other investigators believe that a shower takes as much as or more than the bath. Non-automatic washers use 10 to 15 gallons of hot water, and automatic washers about 10 gallons per load. One company is making heaters in 3-, 5-, and 7-gallon sizes for installation below the sink or at other points of service for use where a need for large quantities of hot water does not exist. (Fig. 152.)

Inlet and outlet pipes for cold and hot water are usually installed at the top of the tank, but occasionally a company places them on the side at the back, where they are out of sight. Insulating the hot-water pipes is recommended. Krappe of Purdue found that an inch of insulation on the pipes resulted in a 12 per cent decrease in heat loss when water consumption was 40 gallons a day, and consequently the thermostat could be set for a lower temperature. Krappe also advises using small-sized pipes. His research proved that a 26 per cent saving in heat loss could be obtained with smaller pipes. Hot water was more quickly available at the faucet with less waste of water and more satisfactory service.

Thermostats are commonly set to maintain water at a temperature between 140° F. and 150° F. Higher temperatures increase the probability of accidents and also cause more deposits from hard water. Because of these lime deposits, there should always be a drain valve close to the bottom of the tank so that sediment may be flushed out at regular intervals. This keeps the water clean and also prolongs the life of the tank. Water of temperatures below 140° F. will not be diluted with cold water to any great extent and consequently the contents of the tank are drawn off more rapidly. When a whole tank of

water is heated to 150° F., almost 95 per cent of the water may be drawn before the temperature of the water will drop below about 120° F. The thermostat is usually hidden behind a hinged door or removable panel. Many postwar heaters are equipped with a temperature dial which the homemaker may set for any desired temperature.



Rite-Way Products Co. (*a*) *Cleveland Heater Co.* (*b*)

FIG. 152. (*a*) A small water heater installed below the sink, or (*b*) in a cabinet which supplies additional work surface in kitchen or laundry.

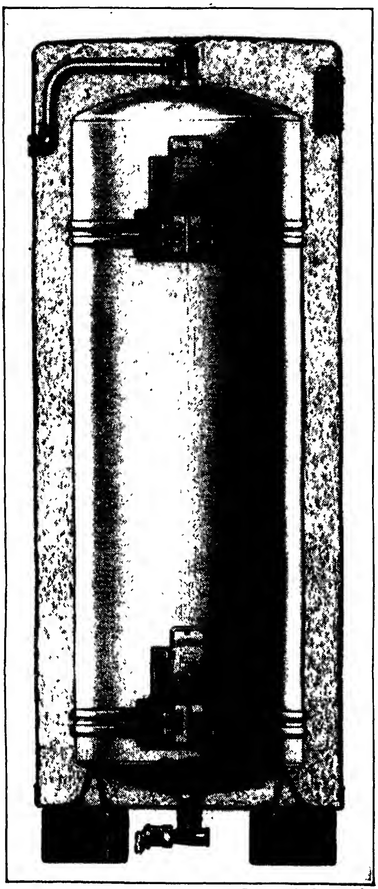
Legs or base should be adjustable, so that it is possible to level the heater on an uneven floor and so prevent undesirable strain on connecting pipes.

ELECTRIC WATER HEATERS

Electric heaters are of the single-unit or two-unit type. If there are two units one is placed as near the bottom of the tank as possible, the second unit approximately one-fourth of the distance from the top. (Fig. 153.) Each unit has its own thermostat. The units may encircle the outside of the heater or may be the immersion type within the tank itself. In most tanks, only one unit can operate at a given time, and the lower unit does the major job of heating the water. The

upper unit will start operation only after about 75 per cent of the hot water has been withdrawn.

The National Electric Manufacturers Association, NEMA, has set up standards for unit ratings for water heaters.



General Electric

FIG. 153. An electric water heater with two units.

For single-element heaters the wattage shall be:

Tank Size, gallons	*Wattage Ratings/ Gallon Capacity*
30	1500
40	2000
52	2500
80–90	3000

For the upper and lower units of the two element heaters:

Tank Size,	*Wattage Rating of Units*	
gallons	*Upper*	*Lower*
30	1000	600
40	1250	750
52	1500	1000
80–90	2500	1500

Wattage ratings are based on 30 watts per gallon of tank capacity for the upper unit and 20 watts per gallon for the lower unit.[1]

Most electric water heaters are operated at certain off-peak hours when there is minimum demand on the power output of the utility company. Sometimes only the lower unit is so controlled, the upper unit being free to operate if necessity arises. The turning off and on of the unit is automatically regulated. It is accordingly important that the capacity of the tank be sufficiently large to insure a supply of hot water at all times and yet allow the heating to take place from the lower unit when the electric rate is lowest. Frequent use of the upper unit greatly increases cost of operation.

[1] *Automatic Electric Water Heating,* General Electric Co., p. 26.

It is an advantage to have the heater located as close as possible to the place of maximum use so that there will be a short pipe connection between tank and faucet. To meet this need counter-high water heaters are manufactured for kitchen installation. The table top of the heater is a section of the work surface. (Fig. 152.) Such a location cuts heat loss in the connecting pipes.

Gas water heaters

Gas water heaters are available in a variety of sizes and types, both automatic and non-automatic. The automatic storage heater is probably the most satisfactory for all-round family use. The accompanying chart, approved by water-heater manufacturers and gas utility companies, suggests the size of automatic storage heater that should be installed according to number of bathrooms and bedrooms in a home.

Sizing Chart

For Automatic Storage Gas Water Heaters

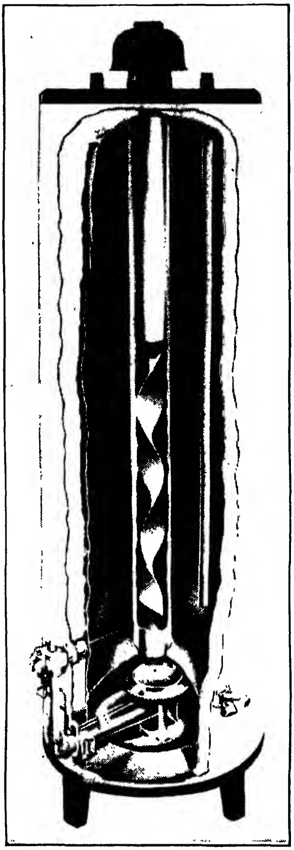
Minimum Recommendations for Normal, Average Hot Water Requirements

Number of Bathrooms	*Number of Bedrooms*	*Minimum Storage Capacity, gallons*
1	1 or 2	30
1	3 or 4	40
2	2 or 3	40
2	4 or 5	50
3	3	50
3 or 4	4 or 5	75

In such a heater, the water tank is heated by a gas burner, usually located below a central flue through which the heat rises. Large tanks may have more than one flue. The flue is provided with a series of fins or baffles that retard the flow of hot gases and so allow time for the transfer of heat to the water. (Fig. 154.) A draft diverter is placed over the top of the flue. It protects the flue against down-chimney drafts that might extinguish the pilot and makes possible the maintenance of an even, unfluctuating flame during the heating cycle.

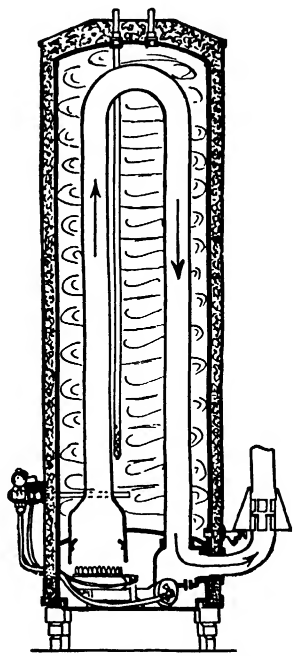
One tank has a U-shaped flue that offers extra surface for heat transmission. (Fig. 155.) The draft diverter in this type is at the side of the tank near the bottom. Instead of a central flue, some tanks have a surrounding flue between the water reservoir and the insulated outer shell. Manufacturers of this type claim very rapid recovery of temperature when cold water is drawn.

Another automatic water heater is the instantaneous or continuous-flow type, which is so constructed that a very large heating unit is automatically turned on whenever a faucet is opened. This burner



Rheem Mfg. Co.

FIG. 154. Gas water heater with baffled central flue. Note draft diverter at top.

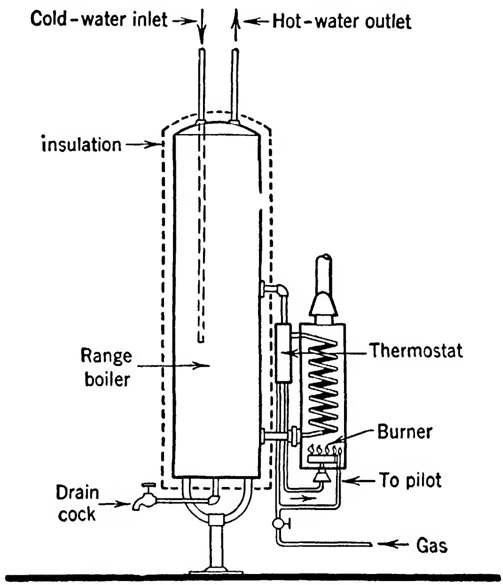


Handley-Brown Heater Co.

FIG. 155. A U-shaped flue offers extra surface for heat transmission.

heats the water so rapidly that it may be drawn at once, the rate at which the water passes through the heating coil and, therefore, the temperature of the water being regulated by a thermostat. No storage tank is required. This type of heater may be very expensive to operate if the consumer is careless in the use of hot water, but it is popular in regions with corrosive water, for all connections are of copper and brass.

The non-automatic tank heater is the simplest type and the least efficient. The tank of sheet steel or copper in the average family size has a capacity of 30 gallons. The burner, below the tank or in a sidearm attachment, is of cast iron and is lighted by hand. In the sidearm heater the water passes through a helically wound copper coil above the burner and, as it heats and expands, rises through a pipe to



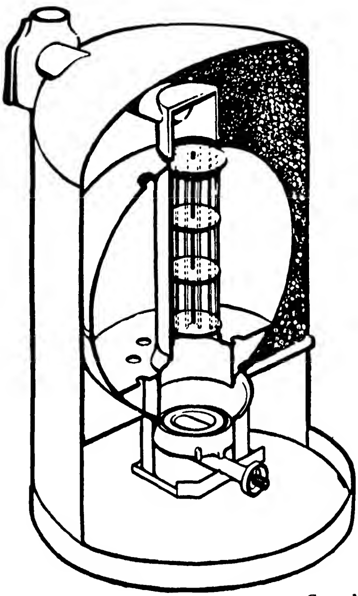
Assoc. of Gas Appliance and Equipment Manufacturers

FIG. 156. Non-automatic sidearm heater can be converted to the automatic type by adding insulation and a thermostat.

the top of the tank, and cold water from the bottom flows into the coil. (Fig. 156.) Circulating in this way, the water is gradually heated throughout. Water is drawn from the top of the tank so that the hottest water is always obtained first.

The other non-automatic type has the burner below the tank. Flues carry the combustion products up and around the tank to aid in heating the water. This type is now usually supplied with a two-way burner, which allows either a large or a small flame, similar to the burner on some of the new gas ranges. The simmering section of the burner burns continuously and provides enough heat to give a tank of 140° F. water in 10 hours. This supplies sufficient hot water for ordinary daily household use. When a larger amount is needed for laundry, the large burner may be lighted.

A conversion type of circulating tank heater replaces the non-automatic side-arm heater with one that heats automatically. The tank should be examined for size and condition before the change is made and, if suitable, should be insulated with 2 to 4 inches of approved material. Figure 156 shows a conversion heater.



Servel

FIG. 157. A hot-water tank of spherical shape.

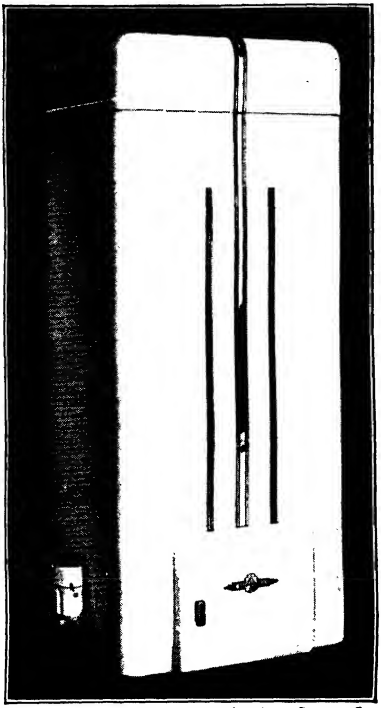
Most tanks are cylindrical, but one company is producing a spherical or ball-type tank, a shape that best withstands pressure. (Fig. 157.)

Burners are of varied construction: ribbon flame, slotted, Bunsen blue flame, and jet-type, in which the burners are individually raised to afford easy access of secondary air. Most manufacturers provide for secondary air intake at the bottom of the heater, but one company has the air intake at the top of the tank and claims that such construction checks the air flow during the off periods of the burner and so minimizes heat loss and cuts down on fuel consumption. Any kind of gas that is available may be used.

Automatic gas heaters are supplied with thermostats, frequently of the snap-action type, that are actuated by cold water entering the tank as the hot water is withdrawn. In the snap-acting thermostat, the valve passes instantly from the closed to the open position, and vice versa. The thermostat should maintain a steady, even temperature in the water. If for any reason the pilot light is extinguished, a safety shutoff valve at once cuts off the entire gas supply. The pilot must be relighted before gas will again flow to the main burner. A receptacle below the burner is often provided to catch any condensation from the flue gases which might interfere with complete combustion.

According to the *AGA Approval Requirements for Gas Water Heaters*, the corrected thermal efficiency of circulating, instantaneous, and non-automatic storage water heaters must be not less than 70 per cent. The approval requirements also state that "Every automatic combination heater and water storage vessel of the internal

heater type shall be capable of delivering 60 per cent of its actual storage vessel capacity with a temperature drop of not more than 10° F. below the temperature of outlet water at the start of draw, and 85 per cent of its actual storage vessel capacity with a drop of not more than 30° F. below temperature of outlet water at the start of draw, with the thermostat adjusted to give top-of-tank temperature of 150° ± 2° F." [1]



Perfection Stove Co.

FIG. 158. Oil-burning water heater. A distinctive rectangular design that harmonizes with other modern appliances in kitchen or utility room. A gas-burning heater is also made in this design.

OTHER METHODS OF HEATING WATER

In homes without central heat and even in many small homes with a furnace, water is commonly heated by means of a waterfront in the kitchen range, the water being stored in a nearby tank, usually of 30-gallon capacity.

During the winter months water is frequently heated by connecting the storage tank to a pipe coil in the firebox of the furnace or indirectly by utilizing the heat of the hot-water or steam system. This method is not efficient, for heat absorbed by the coil is not employed for general house heating. Tests show that as much as 20 per cent of the coal burned may be used for heating the water. A similar loss is experienced from the use of water coils in an oil furnace; an additional 40 gallons of oil a month may be required to heat the water.

For the summer the tank is cross-connected to a coal, gas, or electric heater, or the oil burner is operated continuously only for heating the water. In the first case, supplementary equipment is needed; in the second, the life of the burner is shortened.

[1] *Addenda to American Standard Approval Requirements for Water Heaters,* Z21.10–1944.

Automatic oil-burning water heaters are also available, for installation with a separate storage tank or with a built-in tank. (Fig. 158.) They are similar in construction to gas heaters, but connection to an outside flue is desirable if not essential. Fuel oil is used, and the height of the flame is thermostatically controlled.

Water softeners

Hard water has so many undesirable characteristics that it should be softened whenever possible. When the entire household water system is softened, the deposit of sediment in the hot-water tank is eliminated. The common method of softening is by the zeolite process based on the principle of ion exchange. Hard water contains salts of calcium and magnesium. These salts are replaced by the sodium from the sodium silicate of the zeolite, and the magnesium and calcium precipitate out, leaving the water soft. When the sodium is exhausted, a fresh supply of common salt, sodium chloride, is added and the zeolite is regenerated. After the system is installed, the only operating cost is for the sodium chloride, which is relatively inexpensive.

Water-softening tanks are similar in appearance to hot-water tanks. The tank contains a bed of zeolite and one or more beds of filtering gravel. The incoming water is sprayed over the top of the zeolite and filters down through it and the gravel, losing its hardness on the way. In certain communities a water-softening service is available on a monthly basis. The water-softening tank, which contains zeolite, is replaced each month or 6 weeks with a new one. This arrangement allows a small tank, which occupies very little space, to be used. The homemaker pays for the service monthly, just as she pays for her other utilities, and is relieved of all maintenance responsibility.

Summary

1. Motor-driven washers and ironers are very desirable labor-saving appliances.
2. Gears are necessary in transforming the electrical energy of the motor into the mechanical energy of the moving parts of the machine.
3. Friction is reduced by the use of bearings.
4. Removal of dirt depends upon emulsification and adsorption of the dirt by the soapy solution.
5. Soft or softened water is prerequisite for adequate removal of dirt.
6. Choice of soap or soapless detergent is largely determined by the

type of fabric to be laundered. Fabrics are made of vegetable, animal, and synthetic fibers.
7. Stains should be removed before washing.
8. Three types of washers are manufactured: agitator, vacuum cup, and cylinder. Agitators vary considerably.
9. Each washing machine seems to have an optimum washing period. With a longer period the dispersion of the dirt is increased, resulting in the redeposition of the soil in the fibers of the cloth.
10. Water may be extracted by a wringer or centrifugal drier.
11. The automatic washer washes, rinses, and damp-dries the clothes without the hands touching them. A variety of agitating devices is used.
12. The automatic drier eliminates dependence on weather and saves time and energy.
13. Hand irons may be dry, steam, or combination irons. Automatic heat control is essential in using the iron with different kinds of fabrics.
14. The ironing board should be sturdily constructed with a well-padded surface for resiliency. It should be adjustable in height.
15. Ironers are of the roll or flatplate type. The shoe is of chromium-plated iron or steel or of aluminum. Each end of the shoe has a separate automatic heat control. Ironers with two open ends are preferred for ironing certain types of clothing.
16. Washers may be connected, if necessary, to a light socket, though a convenience outlet is preferable. One-thousand-watt irons and the ironer must always be connected to a convenience outlet.
17. Hot water is essential for cleanliness and health.
18. Water may be heated by gas, electricity, oil, or coal. An automatic storage heater, which maintains water at a temperature of approximately 150° F., is desirable.

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11

Cleaning Equipment

IN MODERN HOMES the surfaces on which dirt and dust collect are many and varied, but the use of modern cleaning equipment reduces the time and effort required to keep these surfaces clean.

SELECTING CLEANING EQUIPMENT

Various types of cleaning equipment are available today. Proper selection becomes a matter of knowing the composition, texture, or finish of the surfaces to be cleaned; the types of soil that collect in and on them; and the type of cleaning equipment that operates most effectively in removing dirt from each surface.

In selecting an efficient electric cleaner, consideration must be given to the design, since this affects performance, and to the quality of the materials and workmanship used in its construction, since these determine durability. The efficiency of an electric cleaner is dependent on such factors as size and shape of the nozzle; size, shape, and design of fan and fan chamber; type and design of the rotating part; and speed and efficiency of the motor. The quality of the various parts and the over-all cleaning effectiveness of an electric cleaner can be determined only by carefully controlled tests. In general, however, cleaners combining sweeping and carpet vibration with suction remove more embedded dirt than cleaners employing suction alone.

Equipment that can be used for several jobs should be selected whenever possible, since it reduces the initial investment, simplifies the problem of storage and care, and necessitates carrying fewer tools from room to room during the cleaning process.

ANALYSIS OF THE CLEANING PROBLEM

Although the thorough cleaning of all home furnishings is important, recent studies indicate that 85 per cent (sometimes as much as 97 per cent) of all the dirt that accumulates in a room is in the carpet. Cleaning carpets and rugs is, therefore, of prime importance in modern homes. To understand the problem it is helpful to have some basic knowledge of carpet structure.

Carpet structure

Carpet is really a two-part fabric. The interweaving of cotton warp yarns with weft yarns of cotton, jute, or Kraft-cord produces a thick, firm back. Tufts of wool or worsted yarn are woven into the back in loops and may be cut or left uncut. The method of attaching the pile yarns to the back determines the type of carpet. In the different types and grades of carpet the number of rows of pile tufts per inch lengthwise varies from four to thirteen, and the pile height from 1/8 to 1/2 inch or more.

Between the rows of pile tufts, and between individual tufts, there is much open space where dirt may collect. Owing, then, to these structural characteristics carpet has an enormous capacity for storing dirt which other home-furnishing fabrics do not have.

Carpet dirt

The properties of the complex substances that accumulate in and on carpet also add to the carpet-cleaning problem. Physically carpet

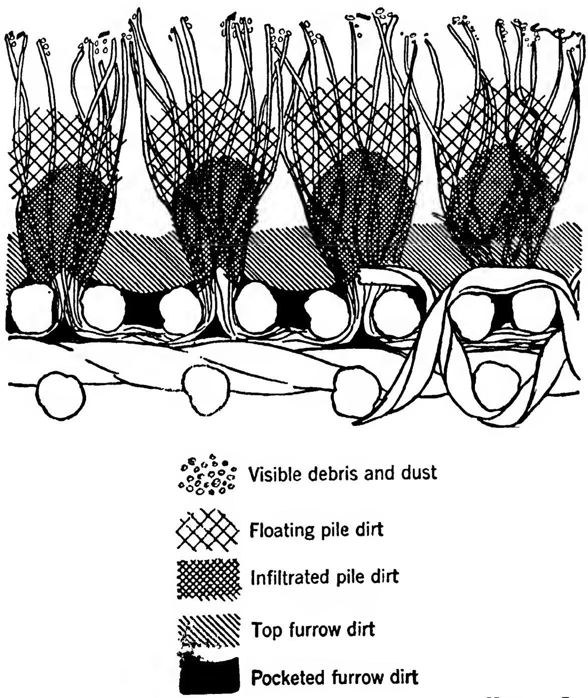


FIG. 159. Analysis of rug dirt.

dirt may be separated into three groups according to particle size: surface litter, which includes thread, hair, lint, paper scraps, and sewing-room litter; fine dirt and dust, which, being light in weight, collects in the upper part of the pile tufts; and sand and grit, which, because of their weight, readily become embedded in the base of the pile tufts, in the open spaces between the pile rows, and even in the tiny pockets formed by the interweaving of the backing yarns. (Fig. 159.)

Surface litter is unsightly but less harmful than the other two types of carpet dirt. It is also more easily removed. Greasy, sticky organic substances, which combine with the finely divided particles just below the carpet surface, cause that portion of the dirt to cling tenaciously to the pile yarns. This, and the more deeply embedded dirt and grit, are the most difficult to remove; if the embedded dirt has sharp cutting edges that press against the soft woolen pile yarns under the friction of use, the result may be a loss of pile tufts and a worn appearance.

Carpet-cleaning equipment

The primary function of an electric vacuum cleaner is to remove surface dirt and embedded dirt and grit from floor coverings. Surface

Hoover Co.

Fig. 160. A very dirty rug may become

Hoover Co.

Fig. 161. a well-cleaned rug, by using an efficient electric cleaner.

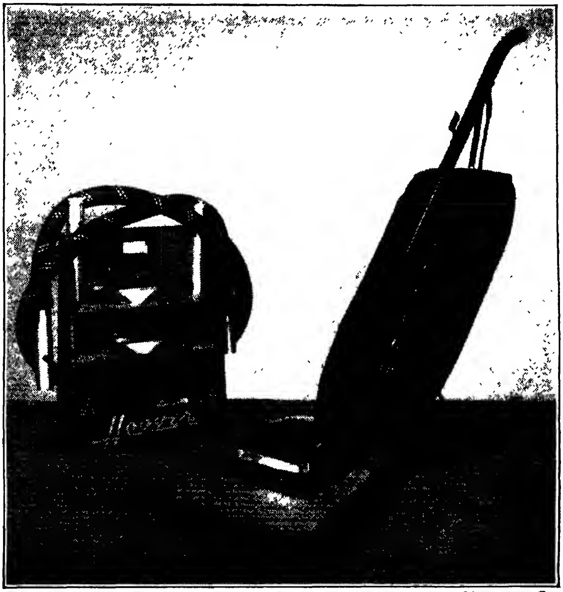
litter can be removed readily by surface cleaning methods, the sweeping action of a carpet sweeper or the suction and sweeping action of the vacuum cleaner. To remove both light and heavy dirt and grit embedded below the pile surface requires carpet-vibrating action.

This loosens the embedded dirt and bounces it to the carpet surface where suction and sweeping action can carry it into the dirt receptacle. (Figs. 160 and 161.)

ELECTRIC CLEANERS

Types and identifying characteristics

Electric cleaners are usually classified, according to the principles of cleaning action employed, into straight suction, motor-driven brush,



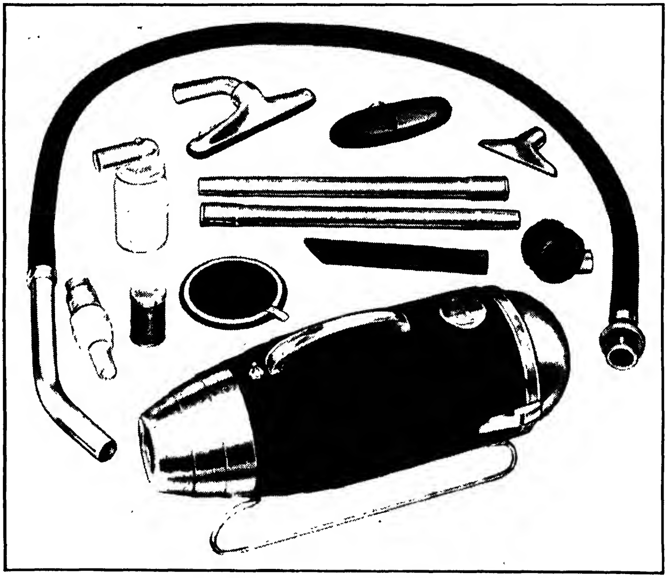
Hoover Co.

Fig. 162. An upright cleaner with attachments.

and motor-driven agitator. The straight-suction cleaners are made in both upright and cylinder forms; the motor-driven brush and motor-driven agitator types are of the upright design. (Figs. 162 and 163.) Each type of electric cleaner has definite design characteristics by which it may be identified.

Straight-suction cleaners. This type of electric cleaner may be identified by the slitlike nozzle opening and by the absence of any rotating part in the nozzle. (Fig. 164.) Suction is the principal cleaning action, and straight-suction cleaners usually have a motor of $\frac{1}{3}$ to $\frac{1}{2}$ horsepower in order to provide the high suction required.

Straight-suction cleaners may also add sweeping action by means of a stationary brush mounted outside the nozzle lips. Such brushes have one or two rows of bristles, and they may be detachable, perma-

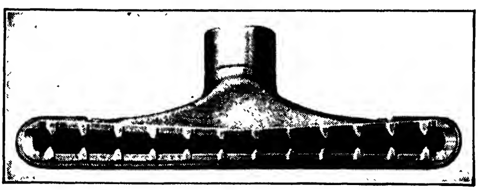


Landers, Frary and Clark

Fig. 163. A metal-cylinder cleaner with attachments.

nently attached but adjustable, or floating. They combine with suction to provide some pile agitation and thereby aid in loosening thread, yarns, and other types of clinging surface litter.

Stationary brushes on straight-suction cleaners, when in operating position, have a tendency to dig into the carpet pile and thus increase



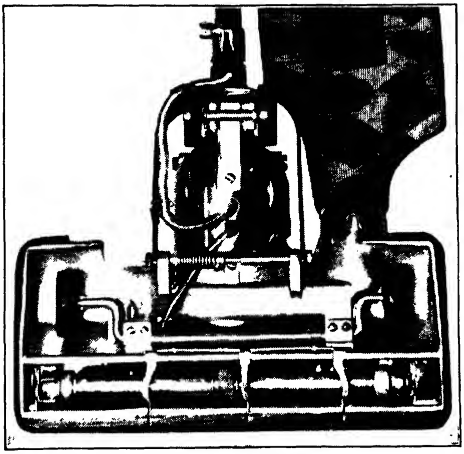
Landers, Frary and Clark

Fig. 164. Straight-suction nozzle.

the human energy required to push the cleaner. They also tend to break the seal between the nozzle lips and the carpet. Both these difficulties may be overcome by the use of detachable brushes, or

brushes which can be adjusted out of operating position. A floating brush does not need to be detachable since it rides by its own weight over the carpet surface and does not increase the effort required to operate the cleaner.

Motor-driven brush cleaners. Suction is also used in motor-driven brush cleaners, but sweeping and carpet vibration are of greater importance in this type of cleaner. Carpet vibration is limited, however, since it must be accomplished by bristle tufts that, by their nature, are



Electric Vacuum Cleaner Co.

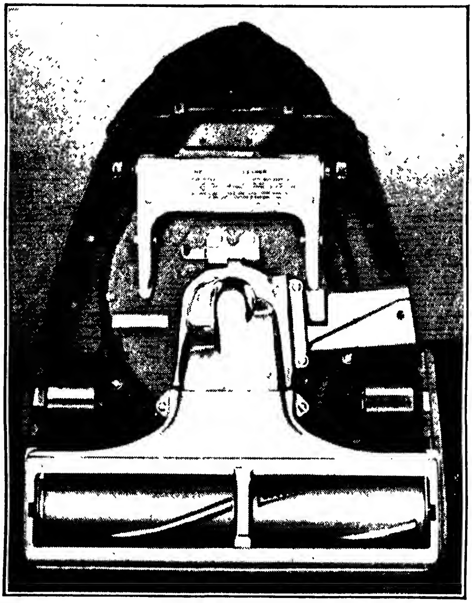
Fig. 165. Motor-driven brush type.

flexible and bend or give when they touch the carpet. The rotating brush is the identifying feature of this type of cleaner and consists of either one or two rows of fairly stiff bristle tufts. (Fig. 165.) Power is transmitted from the motor to this rotating brush by means of a belt passing around the pulley on the end of the motor shaft and around another pulley near the center of the brush roll.

In most motor-driven brush electric cleaners the nozzle is supported by two wheels placed immediately back of the nozzle opening. This permits the carpet to be lifted to the nozzle lips for the entire length of the nozzle. Since the motor-driven brush is rotated at high speed by the motor, regardless of the speed at which the operator pushes the cleaner, it sweeps the carpet more thoroughly than is possible with the stationary brush on a straight-suction cleaner.

Motor-driven agitator cleaner. This type of electric cleaner also employs three cleaning principles, suction, sweeping, and carpet vibration. Carpet vibration is accomplished, however, by a rotating

cylinder which differs in design from the brush roll in that it is equipped with two curved vibrator bars. (Fig. 166.) The rigidity of the vibrator bars on this rotating cylinder produces a more intense vibrating action than is possible with flexible bristle tufts, and, since they do not wear even after years of use, their effectiveness remains constant. The function of the bristle tufts in this type of cleaner is sweeping only; therefore, they can be soft and flexible.



Hoover Co.

FIG. 166. The motor-driven agitator type.

In this type of electric cleaner, as in motor-driven brush cleaners, the nozzle-supporting wheels are placed back of the nozzle opening. Since carpet cannot be vibrated against a hard surface, suction lifts the carpet off the floor into contact with the nozzle lips, curving it slightly up into the nozzle opening. When a vibrator bar comes into contact with the uplifted carpet it depresses it slightly. As the rotating cylinder turns, the vibrator bar passes out of position, but before the row of bristle tufts is rotated into place there is time for suction to lift the carpet again so that sweeping action is possible. The agitator continues to turn and again brings the vibrator bar into contact with the uplifted carpet. This constant up and down motion, or vibration, takes place at a high rate of speed and loosens dirt that has become

deeply embedded within the carpet. With this embedded dirt loosened and lifted to the surface of the carpet, it is easy for the air stream, which has been set in motion by fan action, to carry the loose dirt into the nozzle, through the air passage into the fan chamber, and thence into the dirt receptacle. The cleaning action that takes place under the nozzle of the motor-driven brush cleaner is similar except that the amplitude of carpet vibration is less, owing to the flexibility of the bristle tufts.

Electric cleaners equipped with a rotating agitator are erroneously credited with removing a slightly higher percentage of loose pile yarns from carpet than a cleaner equipped with a motor-driven brush. Motor-driven brushes that have stiff bristle tufts remove somewhat more loose carpet pile yarns than those with soft bristles. The removal of loose yarns from pile tufts is, however, unimportant in the over-all life of a carpet or rug. Any woolen yarns that can be removed from well-made carpets are only shearings and fibers that were too short to be caught and held by the weft yarns of the carpet backing. Dirt and grit, if allowed to remain in a carpet by ineffective cleaning methods, are undoubtedly more harmful.

Principal parts

An electric cleaner has many parts, but the principal ones are nozzle, fan and fan chamber, motor, and filter or dirt receptacle. Attachable cleaning tools are also important and are available with many cleaners.

Nozzle. In motor-driven brush and agitator cleaners the nozzle is the part that houses the rotating brush roll or cylinder. The nozzle of the straight-suction cleaner is similar but somewhat narrower and contains no rotating part. It is the perimeter of the nozzle, or the nozzle lips, that make direct contact with the floor covering or other surface to be cleaned.

In motor-driven brush and agitator cleaners and in standard-design straight-suction cleaners the nozzle is an integral part of the main frame or casting. In cylinder cleaners a flexible tube and one or two metal tubes form the connection between the cylinder and the nozzle. A variety of plain and brush nozzles are available with cylinder cleaners, some having toothed or serrated edges.

Fan and fan chamber. The efficiency of the fan in producing suction depends upon the number and design of the fan blades, the size of the fan, the speed of operation, and the design of the fan chamber in which it rotates. The fan in an upright cleaner consists of one set

of blades arranged about a hub or fan eye. A fan mounted at the end of the motor shaft rotates at the same speed as the motor. (Fig. 167.) It is located in front of the motor, if mounted horizontally, or below the motor, if mounted vertically. A two-stage fan, consisting of a double set of curved blades, is used in cylinder-type cleaners and is housed in the cylinder with the motor and dirt receptacle.

The rapid rotation of the fan in an electric cleaner throws the air outward by centrifugal force and creates a partial vacuum at the hub. Outside air at atmospheric pressure rushes in through the nozzle opening to fill this vacuum. This inrushing air reaches its highest velocity and becomes most effective in dirt removal immediately under the nozzle lips. Dirt that is encountered at this point on the carpet surface can, therefore, be removed by this high-velocity air stream and carried into the cleaner and eventually into the dirt receptacle.

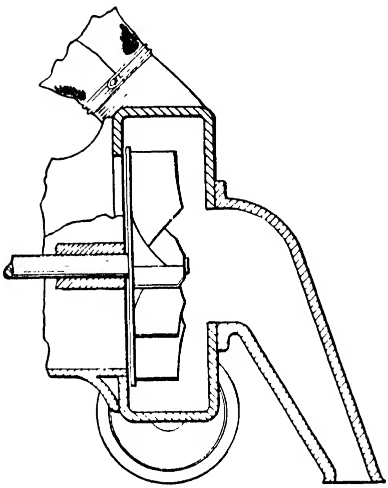


Fig. 167. Fan and fan chamber.

Straight-suction cleaners depend almost entirely upon suction for their cleaning ability, and high suction measurements will generally be found in this type of cleaner. In motor-driven brush and agitator cleaners a larger percentage of the cleaning effectiveness is due to sweeping and carpet vibration. The primary function of suction in these cleaners is to lift carpet off the floor into contact with the nozzle lips, and to provide a current of air that will carry away the dirt loosened by the sweeping and vibrating action.

The characteristics of the carpet on which the cleaner is being operated have considerable effect upon the degree of suction developed. On densely woven carpet, nozzle suction is usually high because of the high resistance to air flow through the back of the carpet. On loosely woven carpet, such as Axminster, a considerable amount of air will pass through the back of the carpet, thus increasing air flow but decreasing nozzle suction.

Motor. Universal motors of the type used on electric cleaners vary from 0.08 to 0.75 horsepower. One horsepower is the equivalent of 746 watts, and the watts output of a 1/5- (0.20) horsepower motor will

be, therefore, $\frac{1}{5}$ of 746 or 149 watts. The efficiency of a motor is the ratio of watts output to watts input, and the efficiency of universal motors is usually about 50 per cent. The significance of this is that the watts input must be approximately twice the watts output. It is the watts input of an electric cleaner motor that is marked on the name plate, and from this figure the cost of operation can be determined. A universal motor may be operated on either direct or alternating current, but should not be applied to any voltage more than 10 per cent above or below the voltage stated on the motor name plate.

Motors used on electric cleaners vary in speed from 6000 to 16,000 revolutions per minute. High speed in a motor does not necessarily mean high suction, however, because the amount of suction depends primarily upon size and design of fan and fan chamber. Exceptionally high speed in an electric motor may tend to shorten motor life. Motors used on electric cleaners usually have a small ventilating fan to assist in maintaining a low operating temperature.

In some electric cleaners two motor speeds are provided, a low speed for cleaning small thin rugs and a higher speed for use on heavy floor coverings. Some electric-cleaner motors are also equipped with a radio filter to eliminate static in neighboring radios while the cleaner is being operated.

In most electric cleaners today the motor rotates on either ball bearings or self-aligning, self-lubricating sleeve bearings, neither of which require lubricating by the user, although they should receive periodic attention at a factory-operated service station.

Dirt receptacle. The type of dirt receptacle generally used on an electric cleaner is a bag of cotton cloth that, if properly made, will retain the dirt and allow clean air to pass through the tiny interstices in the cloth. (Fig. 168.) Much research has been done to develop cotton cloth that will continuously serve as a filter and not lose its effectiveness after a short period of use. To meet these requirements one manufacturer has set up the following specifications: the number of looms per weaver must be limited in order to guarantee cloth without defects; the humidity of the spinning rooms must be controlled to prevent variations in yarn tensile strength; the cloth must be tested frequently during the weaving to make sure that it meets the predetermined filter standard.

Disposable bags of paper or paperlike materials are also used as filters in some cleaners. One such filter used on a cylinder cleaner

is cone shaped and fits over a perforated steel motor guard that projects downward into a metal dirt receptacle. Another cylinder cleaner has an inverted conical filter of cloth located above the metal dust receptacle. Still another has a metal container partly filled with water, thus permitting the dirt to drop into the water and the air to flow out through an outlet at the top. One cleaner of the agitator type has a dirt bag of fiber felt. This is a paperlike material having excellent filtering ability; it is durable and easy to empty because of its smooth inner surface. This bag is protected by a zippered cloth cover.

The size of the filter used on an electric cleaner is of great importance and is related to the volume of dirt that the cleaner handles during the usual cleaning period. For maximum filtering ability the surface of a dirt receptacle should measure approximately 500 square inches.

Attachable cleaning tools. Most upright cleaners today are sold with attachable cleaning tools, consisting generally of an adapter or connector, a flexible tube, two metal extension tubes, and several nozzle brushes suitable for cleaniing various surfaces other than carpet. There is usually a 5-inch brush for cleaning draperies, cushions, screens, mattresses, high moldings, etc.; an 8-inch brush for cleaning bare floors, under low furniture, etc.; a round brush with long soft bristles for light dusting; and a flat nozzle for cleaning upholstery tufting, the spaces between the arms and seat on upholstered furniture, and other places difficult to reach. These nozzles are similar in many respects to the nozzles furnished with cylinder-type cleaners. (Figs. 162 and 163.)

Suction is the principal cleaning method of attachable cleaning tools since they are intended to remove only light dust which is not embedded. Brush nozzles should, however, be so constructed that the maximum air flow is at the bristle tips. This is accomplished by means of a hard-rubber inner nozzle slightly shorter than the bristle tufts. Without such an inner nozzle the air flow cannot be concentrated at the point of contact between the bristle tips and the surface to be cleaned.

In addition to the usual suction adapter some cleaners are equipped with a blower attachment which can be connected at the exhaust outlet. With the flexible hose and nozzle brushes attached at this point, the cleaner may serve as a hair drier or for spraying light liquids. Some cleaners include a disinfecting attachment, and others a floor-waxing or -polishing brush.

SMALL HAND CLEANERS

Several companies manufacture small hand cleaners that may be used, in some instances, instead of attachable cleaning tools. Hand cleaners are of two types: straight-suction and motor-driven brush. They usually weigh from 3 to 6 pounds, have a handle for ease of manipulation, and are suitable for cleaning automobiles, upholstered furniture, and other surfaces on which the larger cleaner is inconvenient.

USE AND CARE OF ELECTRIC CLEANERS

Nozzle height

All upright electric cleaners, whether straight suction, motor-driven brush, or motor-driven agitator, lift the carpet off the floor during the cleaning process. They are, therefore, designed with nozzle-supporting wheels to hold the nozzle lips at the correct height above the carpet. Since carpet thickness varies in different homes and even in different rooms it is necessary to provide a screw, cam, or foot lever that readily lowers either the front or rear of the machine. An adjustment approximately $\frac{1}{8}$ inch above the carpet surface gives the most effective cleaning. If the nozzle is adjusted too high, suction cannot lift the carpet; if too low, too much human energy is required to push the cleaner. Such adjustment devices, whatever the type, should be clearly marked to indicate the correct nozzle height.

In cylinder-type cleaners the contact between the carpet and the nozzle lips depends entirely on the pressure exerted by the user since there are no nozzle-supporting wheels. For best performance with this type of cleaner it is necessary that the entire perimeter of the nozzle be held firmly against the carpet during the cleaning operation.

On the agitator cleaner and on several makes of motor-driven brush cleaners the nozzle is self-adjusting. This is accomplished by means of two wide wheels immediately back of the nozzle and two narrow wheels at the rear of the machine. Proper balance in design is also necessary.

Frequency of use

Practically all authorities agree on the importance of cleaning carpets and rugs frequently. In fact, the Carpet Institute recommends

that "an electric cleaner be used for a short time every day on each carpet or rug" and "at least once a week all carpet areas be given a *thorough* cleaning with an electric cleaner." The reasons back of this recommendation are sound. An electric cleaner can quickly remove surface litter and the dust and dirt in the upper part of the carpet pile. It is the deeply embedded dirt and grit that are more difficult to remove and require long cleaning periods. Daily cleaning would remove the heavy gritty dirt while it is still on or near the surface and before it has time to become embedded deeply into the pile tufts. Daily cleaning, therefore, requires less total cleaning time per week to keep floor coverings in a sanitary condition.

In spite of frequent regular cleaning with an electric cleaner, rug and carpet colors sometimes become dull because of the greasy organic substances contained in carpet dirt and because of unusually large amounts of coal dust or similar soiling materials that accumulate on them. Under these conditions certain types of surface-brightening materials can be applied, allowed to remain on the carpet as directed by the manufacturer to absorb soiling materials, and removed completely by means of an efficient electric cleaner. Shampooing or solvent cleaning by a commercial rug cleaner may also be desirable occasionally.

The total amount of time required weekly to keep carpets and rugs in a home satisfactorily clean depends upon the type of cleaner, the type and area of the carpet, the density of the carpet dirt in and around the pile tufts, and the resistance to air flow through the dirt receptacle. Some of the earliest time studies made in homes showed an average cleaning time of 8 to 10 minutes per week per 9 by 12 foot rug, but a survey conducted in 1945 by a magazine testing laboratory showed that the length of time homemakers use their electric cleaners apparently has little relation to the amount of carpet. In some homes having only 100 square feet of carpet (equivalent to one 10 by 10 foot rug) the cleaner was run for an average of 11 minutes, but in some homes that had more than twice that area of carpet (225 square feet) only 3 minutes more were spent on carpet cleaning.

Tests in a manufacturer's laboratory have also indicated that several short cleaning periods each week are more effective in carpet dirt removal than one longer cleaning period of equal total length. In tests conducted at the State College of Washington, Roberts found that, for equal dirt removal, straight-suction cleaners must be used for a longer period than other types.

Speed of operation

A survey conducted by a vacuum-cleaner manufacturer showed 1¾ feet per second to be the average speed at which women operated their cleaners, but tests in the Iowa State College household equipment laboratories indicated that more dirt was removed when motor-driven brush and agitator cleaners were operated at a speed of 1¼ feet per second than at a higher speed. Energy expenditure was also less. With straight-suction cleaners, however, cleaning efficiency increases with increased speed, but not in proportion to the increase in energy required to operate the cleaner.

Cleaning the dirt receptacle

The stream of air set in motion by the fan in an electric cleaner starts at the nozzle lips, flows through the nozzle opening, into and around the fan chamber, and through the exhaust outlet into the dirt receptacle. Since electric cleaners draw in air at rates varying from 25 to 90 cubic feet per minute it is obvious that all the air cannot remain in the dirt receptacle. The dirt must be retained and the air allowed to flow back into the room. In order to permit the free flow of air, the filter should be cleaned or renewed after each use. (Fig. 168.) Whether the filter is cloth or paper, the openings through which air can pass are small. If these openings become clogged with dirt the bag pressure, or resistance to air flow, becomes great enough to reduce nozzle suction and consequently the dirt-removing ability of the cleaner. This is the disadvantage of paper bags designed to be discarded when they become full of dirt.

U.S.D.A.

Fig. 168. The dirt receptacle should be emptied after each cleaning.

Although nozzle suction is dependent upon fan efficiency and the seal between the nozzle lips and the floor covering, the effective suction is really the nozzle suction minus the back pressure caused by the resistance to air flow in a clogged dirt receptacle. If the filter is not kept clean, the back pressure steadily increases and the cleaning efficiency of the cleaner decreases.

Bristle length

Since the effectiveness of the motor-driven brush cleaner depends largely upon the sweeping and vibrating action of the rotating brush it is necessary that the brush bristles at all times be of sufficient length to touch the carpet as the brush rotates. Recognizing that bristles of all types become worn after a period of use, manufacturers of motor-driven brush cleaners provide some means of adjusting the brush to successively lower positions in the nozzle. The number of adjustments varies on the different makes of cleaners, but the greater the number the longer the life of the brush roll. The method of determining whether the bristles are the correct length consists merely in placing a straightedge across the nozzle opening. (Fig. 169.) If the bristle tufts touch this straightedge they are sufficiently long to touch the carpet as the brush roll rotates. When, however, the bristles are worn so short that, even though the brush roll has been adjusted to the lowest possible position, the bristle tufts do not touch the carpet, then suction becomes the only cleaning action employed by the cleaner although the brush roll is being rotated by the motor. A new brush roll should then replace the worn one.

Hoover Co.

Fig. 169. A method of determining correct bristle length.

This same method may be used to measure bristle length on the motor-driven agitator cleaner and on straight-suction cleaners of conventional design. Brush action, however, is of less importance in these types of cleaners than in motor-driven brush machines.

Belt tension

Electric cleaners that have a rotating brush roll or agitator in the nozzle must be provided with some means of transmitting power from the motor to the rotating part. Rubber belts are quite generally used and have been found to be most practical. The belt passes around a pulley on the end of the motor shaft and around another pulley on

the brush roll or agitator and transmits power from the motor to the rotating part. If the belt breaks or becomes inoperative for any reason, so that the rotating part fails to turn, or turns at a speed too low to be effective, the efficiency of the cleaner is reduced. The belt is, therefore, an important part of electric cleaners of these types.

Belts differ greatly in the total period of time over which they will give satisfactory service by retaining sufficient tension to drive the rotating part at the correct speed. When used in what might be called an average home, a well-made belt should give good service for several months, perhaps a year, barring such accidents as cutting by sharp objects which the cleaner may pick up. It is advisable for the user of an electric cleaner to check the condition of the belt frequently.

Lubrication

The need to oil or lubricate an electric cleaner has now been eliminated by most manufacturers by either self-lubricating sleeve bearings or ball bearings. When an electric cleaner must be oiled by the operator, the manufacturer's directions should be followed accurately.

ELECTRIC FLOOR MACHINES

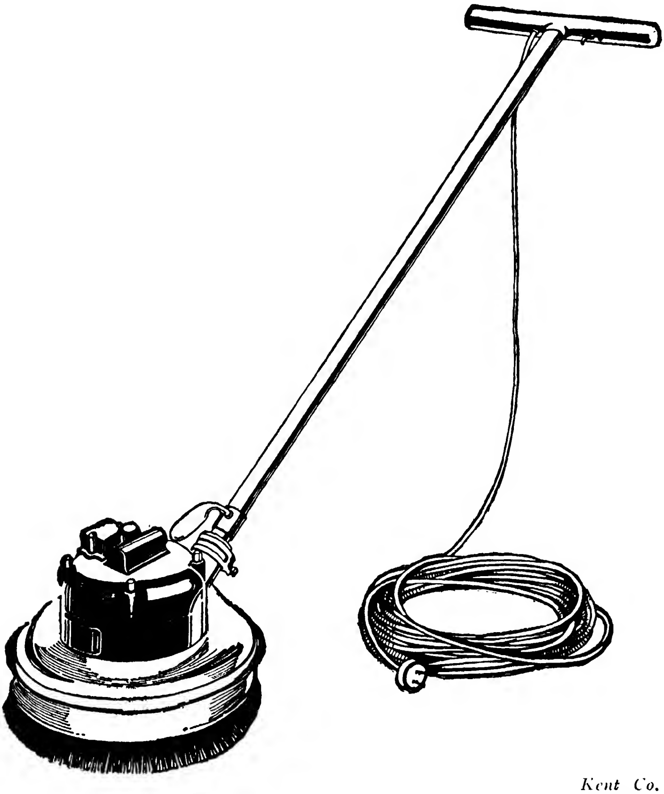
In rooms in which all-over carpets are not used, the common practice is to have rugs of various sizes. This leaves a portion of the floor bare, or it may be covered with linoleum. Wax has proved an excellent preservative for wood and linoleum, increasing the wearing qualities and adding to the appearance.

The electric floor machine used for waxing and polishing is similar to the vacuum cleaner. A ¼- or ⅓-horsepower motor is connected to a revolving brush by a belt or a system of gears; a handle attached to the frame guides the machine; a cord makes connection with the convenience outlet; and a switch turns the current on and off. The cord is usually 40 feet in length. (Fig. 170.)

Brushes

Some floor machines have only one brush; others have two. The brushes rotate vertically on a horizontal shaft, or horizontally around a vertical pivot. Brushes are made of different kinds of fibers, depending upon the use to which they are to be put. Stiff-fibered palmetto brushes are used for scrubbing floors with water and scouring powder; the softer Tampico brushes are used for polishing. Provision

for applying wax differs with different machines. On some, the wax is applied to the floor from a container on the machine either by an electric pump or by dripping out. With others, it is applied by another brush attachment, by a special wax mop, or by hand with a cloth.



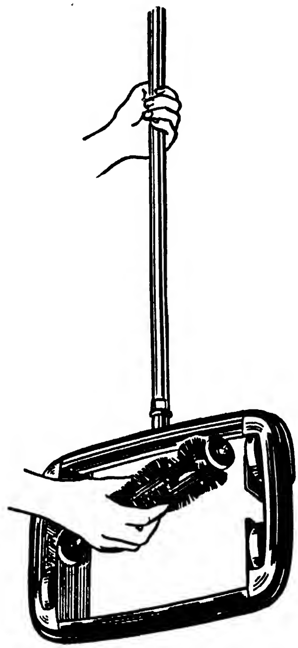
Kent Co.

FIG. 170. Floor machine with various attachments. It can be used for scrubbing, polishing, or refinishing.

Preparatory to refinishing a floor, it is often necessary to remove accumulations of dirt, or old varnish and paint, with the aid of a steel-wire brush. The wire brush is used with a pad of steel wool at least ½ inch thick. After removal of the varnish and dirt, the floor may be smoothed with a sandpaper disk before applying the new coat of paint, varnish, or shellac.

The Tampico brushes usually give a satisfactory polish, but a higher luster may be obtained with the polishing pad. By these

processes the wax is thoroughly worked into the wood and any excess wax is absorbed by the brush, so that the danger of slipping is decreased or entirely eliminated. Wax should be allowed to dry on the floor for 30 minutes before polishing. Never attempt to polish wet wax. It is not necessary for the operator to bear down on the handle, as the weight on the brushes is sufficient to accomplish the work. The machine requires only guidance. The floor machine should be cleaned after using. Dust and surplus wax are easily wiped from the frame when it is warm. Scrubbing brushes may be cleaned in ammonia water, wax-encrusted brushes with turpentine. Then wipe the brushes until they are dry. Oil the machine at regular intervals, carefully following the directions of the manufacturer.



Landers, Frary and Clark

FIG. 171. Carpet-sweeper case and rotating brush.

HAND CLEANING EQUIPMENT

CARPET SWEEPERS

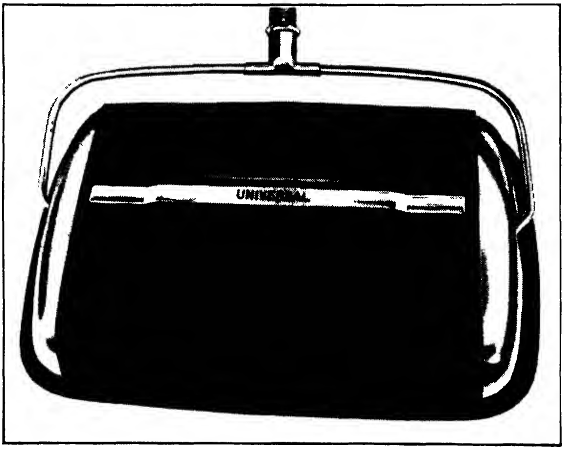
A carpet sweeper is a hand-operated machine designed for the removal of surface dirt from rugs and carpets.

The cleaner consists of a long-handled metal or wooden case on wheels, in the center of which is mounted a rotating brush, preferably made of Chinese bristles. (Fig. 171.) By pushing the sweeper back and forth the brush rotates and picks up dust, ravelings, etc. The bottom of the sweeper consists of two pans, one in front and one in back of the brush. As the dirt is picked up by the rotating brush it is carried into the case and dropped into one of the pans. For best cleaning results, a sweeper should be pushed with as little pressure as will do the work and with smooth even strokes. A rubber bumper around the edge of the sweeper case protects furniture from being marred. (Fig. 172.)

Good sweepers have an automatic brush-setting device to adapt the sweeper for sweeping on rugs having low, medium, or high pile, and they have a built-in comb device for cleaning the brushes. In some sweepers this is a metal bar with a double row of teeth that make contact with the brush as it rotates. Others have two pivoted combs,

which move into and out of contact with the brushes, depending on the direction of motion of the cleaner. Still others have removable cleaning combs that are used only when it is necessary to free the brushes of dirt and matted material.

Sweepers differ in the method and ease of emptying the pans. Those with a lever on the top of the case which can be pushed with the toe, to open the pans without stooping, are the most convenient.



Landers, Frary and Clark

FIG. 172. Rubber bumper around edge of sweeper case protects furniture from mars.

In some designs the pans open from the bottom; in others, at the ends.

Sweeper brushes should be kept clean, and dust pans should be emptied after each use. This is important if the sweeper is to operate easily and efficiently. Also if the sweeper is stored with the bottom part standing vertically, dirt left in the pans will drop on the brush and later to the rug or carpet where the cleaner is used. Threads, hair, or string wound around the axle of the brush should be clipped with scissors to make complete removal easy.

Brooms

One of the most commonly used pieces of cleaning equipment is the broom. Brooms come in a variety of sizes and weights. They are made of broom corn and other fibers, most commonly Chinese palm and Tampico. Brooms made of broom corn are the least expensive but are shorter lived than those made of other fibers.

A good-quality broom-corn broom is made of a mixture of curly and rough fibers stitched together at the top. These fibers should have few split ends, and the splits should be short.

Broom-corn brooms should not be put in water, as water causes deterioration of the fiber. They should be stored by hanging free of the floor or by resting on the end of the handle.

Brooms of Chinese palm are more satisfactory and last longer but they cost more than those made of broom corn. In sweeping, palm-fiber brooms do not flip up the dust and they wear down evenly. As they are not affected by water they are especially useful for cleaning porches, walks, or rough floors such as basements, farm dairies, and other farm buildings. Brooms of this type are made by setting the fiber in a metal or rubber jacket attached to the handle. Below the jacket is a metal binder or rows of stitching. Unlike the corn broom, as the fiber wears down the stitching can be removed, thus lengthening the life of the broom. Palm-fiber brooms come in several weights and fiber lengths. The lighter-weight brooms are more satisfactory for household use; the longer fibers give the longest wearing quality.

In Tampico-fiber brooms the tough vegetable fibers extend about 4 inches from a hardwood block. They are more efficient and durable than the broom-corn type but are more expensive than either broom-corn or palm-fiber brooms.

To clean Chinese palm or Tampico brooms dip them up and down in clean water. If badly soiled they should be washed in lukewarm suds, rinsed thoroughly in clear water, and hung up to dry. Brooms should never be stored with the fiber resting on the floor.

Broom handles are made of smooth-finished maple, pine, and birch. Shellacked, varnished, lacquered, or enameled maple is used on the best brooms, and pine, untreated but smooth finished, or birch is usually used for cheaper ones. Pine wears well, but birch breaks easily.

Brushes

Brushes are available to meet the needs of almost every household cleaning job. Like brooms, they are designed for specific jobs, some for one, others for dual use. They make useful tools as they tend to gather and hold dust instead of scattering it. Brushes are made of tufts of horsehair, goat hair, palmetto, palmyra, Tampico, or plastic fibers, or pig or boar bristles cemented or stapled in wood or plastic or twisted in wire. The type to be selected depends upon the household furnishing to be cleaned. Where a stiff brush is desired the

bristle brushes are usually the most desirable and satisfactory. Brushes of hair are the softest. Hair and bristle brushes hold dust better than fiber brushes.

In a good twisted-wire brush the twists are close together, making a full stack. In cheap brushes wire that will rust is sometimes used instead of rustless galvanized wire. In selecting a twisted-wire brush be certain that it is made of non-rusting wire.

Proper care of brushes is important. All brushes should be washed periodically in warm suds, rinsed thoroughly in clean water, shaken to straighten bristles or fibers, and preferably hung up to dry. Brushes in which the fibers are set in wooden blocks should be dried with the bristles down if they are not hung to dry. All brushes should be stored hanging on hooks.

Floor-polishing brushes

These brushes are of two types, hand and electrically operated. In hand brushes, stiff vegetable fibers are set in heavy blocks weighing about 5 to 15 pounds. The handle is hinged so that it swings easily. The hand brush is inexpensive in comparison with the electrically operated one, but it requires a great deal of human energy to operate it.

Scrub brushes

Inexpensive scrub brushes are usually made of Tampico fiber; more durable ones are made of palmetto fiber, which is not so soft. Long-handled scrub brushes should be used when possible to eliminate getting down on hands and knees. In selecting a brush without a handle be sure that it feels comfortable in the hand.

Floor scrub brushes

The best grade of floor scrub brushes are made of grade A horse-hair, with tufts stapled firmly in a hardwood block. These blocks vary from 12 to 18 inches in length and are about 3 inches in width. In selecting a floor brush look for one in which the handle can be changed from one side to the other. This makes possible the changing of the handle each week so that the hair will wear down evenly.

Wall brushes

Best-grade wall brushes are made from the soft white hair from the side or beard of a goat, twisted in rustless galvanized wire. In the

lower-grade brushes, hair from under the goat's body or horsehair is used. Horsehair brushes are stiffer than those made of goat's hair. They are satisfactory for cleaning walls, but they may snag draperies. For good cleaning, a wall brush should be soft and very full and fluffy. To allow the brush to lie close to the wall the handle is set in a flexible spring socket.

TOILET-BOWL BRUSHES

The most satisfactory toilet-bowl brushes are made of either stiff bristles or Tampico fibers, twisted in a rustless wire in either a circular or ball shape. Those made with bristles or fibers fastened around a wood ball are more difficult to keep sanitary as the wood absorbs water. Bristle brushes are more expensive than fiber but they do not drip after the water is shaken out. Tampico-fiber brushes mat down easily but are cheaper to replace than bristle ones.

UPHOLSTERY BRUSHES

These brushes come in a variety of shapes and designs and are usually made of bristle or hair. In selecting an upholstery brush it is important to consider the fabric to be cleaned. If the fabric is not too delicate a bristle brush is satisfactory. For fine fabrics, such as silk, a soft brush is desirable.

RADIATOR BRUSHES

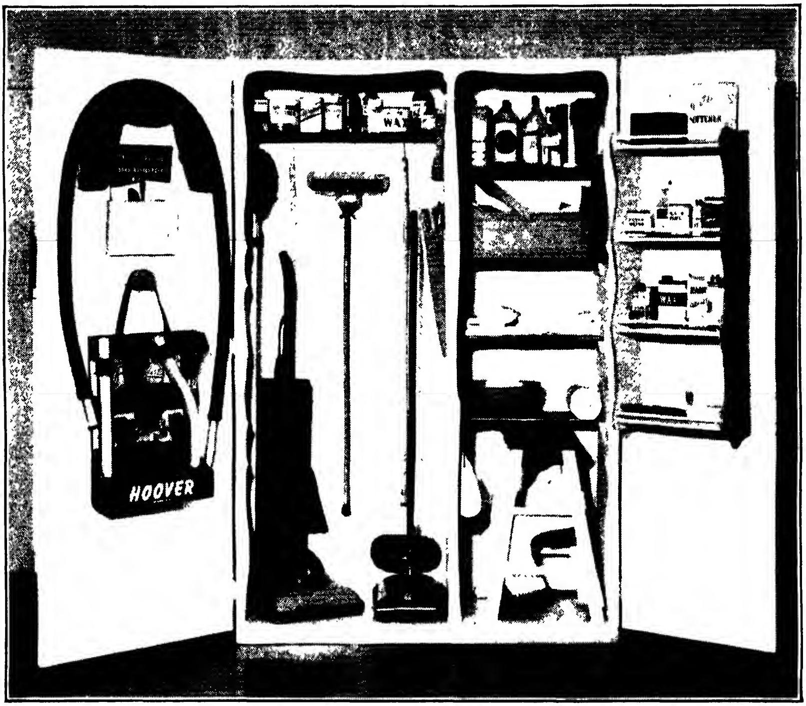
Two designs are commonly found in radiator brushes. The most satisfactory is cylindrical and is made of bristles twisted in rustless wire. Some designs taper toward the end so that they are easy to manipulate into corners. They also can be used for cleaning bed springs and for carved furniture. Another type, less adapted to a variety of uses, is made of hair about 2½ inches long, set into a narrow, flat wood back. This type, though durable, requires more manipulation to use and is less efficient in cleaning some types of radiators.

VENETIAN-BLIND BRUSHES

The best-quality Venetian-blind brushes are made of gray or white goat's hair twisted in rustless wire, of lamb's wool, or of cellulose sponge. They are usually designed with two to five prongs so that several slats can be dusted at one time. The lamb's-wool fingers are usually removable for washing.

CLEANING-EQUIPMENT STORAGE

If cleaning equipment is to be kept clean and in good working condition adequàte storage space should be provided for it. A storage closet for cleaning equipment should be deep and wide enough to ac-



Hoover Co.

FIG. 173. A functionally designed storage closet.

commodate the electric cleaner and other equipment that will occupy floor space, should be high enough so that long-handled tools can hang clear of the floor, should have shelves that are shallow enough to bring everything on them within easy reach, and should have arrangements for adequate ventilation. (Fig. 173.)

SUMMARY

1. Cleaning equipment is available in a wide variety of types and designs, each designed to do a specific job.

2. Carpet dirt consists of surface litter; of dust containing organic matter, grease, and bacteria; and of grit.
3. Vacuum cleaners are classified into types: straight-suction, motor-driven brush, and motor-driven agitator.
4. Straight-suction cleaners have a narrow nozzle free from rotating parts. The motor-driven brush cleaner has a rotating brush mounted between the lips of the nozzle. The agitator cleaner has a rotating cylinder equipped with metal beating bars and brushes.
5. For maximum dirt removal, the nozzle, fan, motor, and dirt filter must operate efficiently. The nozzle should form close contact with the floor covering. Nozzle adjustment is made automatically, semi-automatically, or by manual operation. The fan and the motor must be kept clean. The filter removes the dirt from the air and must be kept clean to reduce back pressure to the minimum.
6. Small hand cleaners and cleaner attachments are used for various kinds of dust removal.
7. The electric floor machine is used for waxing and polishing floors of wood, linoleum, and composition materials.
8. Carpet sweepers are designed to remove surface litter from carpets and rugs. They are not recommended for linoleum.
9. Brooms are made of broom corn and other fibers. Fiber brooms are more satisfactory and last longer but are more expensive than those made of broom corn.
10. Brooms should be kept clean and stored by hanging or by resting on the end of the handle.
11. Brushes are made of horsehair, goat's hair, palmetto, palmyra, Tampico, or plastic fibers. They should be selected on the basis of the cleaning job to be done.

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12

Kitchen Planning

THE KITCHEN HAS UNDERGONE a number of changes in the course of the years. Once the largest and probably the most extensively used room in the house, it was gradually reduced in size until it afforded only sufficient room for one or two persons. Now the trend is away from the small kitchen. It is again becoming the center for other functions than the preparation of meals. The table in the breakfast alcove or the breakfast bar may be used for cutting out sewing materials, sprinkling laundry, or arranging flowers. The children may find this space desirable for study or play. It can double as a planning center. Friends enjoy coming to the kitchen for an evening snack.

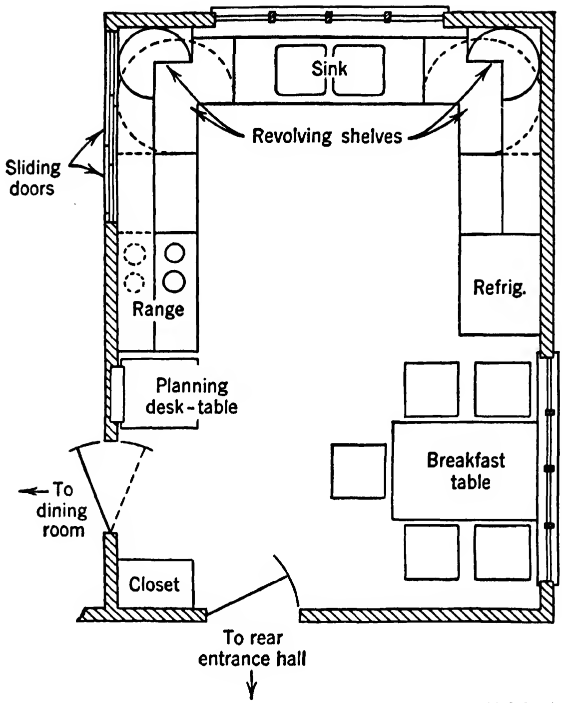
The kitchen is still, however, the center of food preparation. Since this is the most time consuming of the homemaker's tasks, a careful selection of the necessary appliances and their efficient arrangement are essential in order to reduce fatigue to the minimum. Points in selection have been covered in the previous chapters. In this chapter fundamental principles of kitchen planning will be emphasized.

WORK CENTERS

Kitchen equipment is grouped around three work centers: preparation which includes receiving and storage, cooking and serving, and cleaning. Some authorities specify a fourth center, the planning desk, furnished with a telephone for ordering supplies, radio for securing broadcast menus, shelf for cookbooks, drawer space for accounts and memoranda. The top of the desk may be used for an extra work surface if need arises and should have a moistureproof finish. The location of these areas of activity depends upon the size and shape of the kitchen and the position and number of openings. As far as possible, work should progress is a straight line from service entrance to dining-room door.

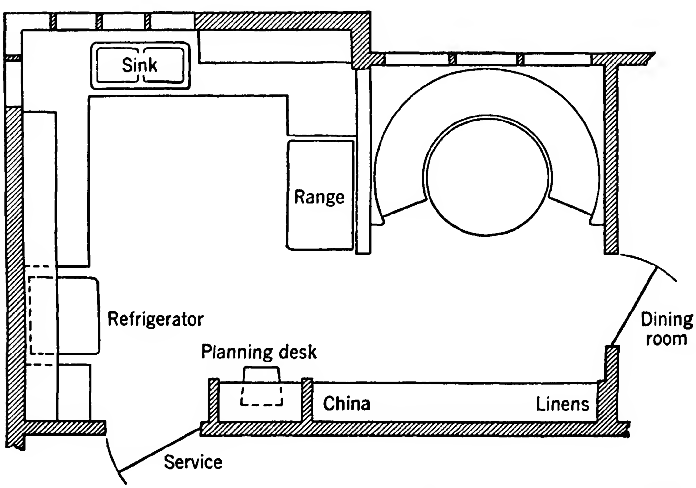
FLOOR PLANS

Most kitchen-planning specialists recognize four basic floor plans: the U-shape, L-shape, corridor or two-wall, and the one-wall. The



U.S.D.A.

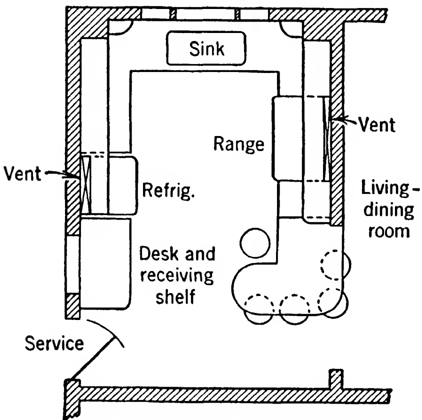
FIG. 174. A step-saving U-kitchen designed by Lenore Sater Thye, Head of Housing and Household Equipment Division, Bureau of Human Nutrition and Home Economics.



Peoples Gas Light and Coke Co. (modified)

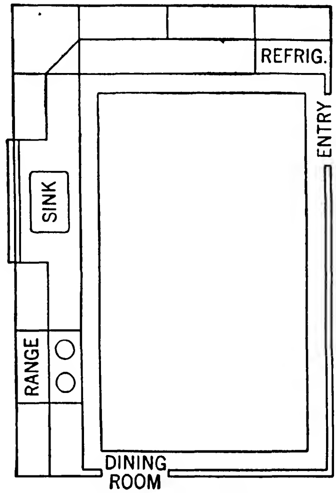
FIG. 175. U-kitchen plan with dining alcove.

U floor plan, shown in Figs. 174, 175 and 176, is considered the most desirable. The sink is at the base of the U with the range center on one arm and the refrigerator on the other. The sink does not neces-



New Freedom Gas Kitchen Bureau

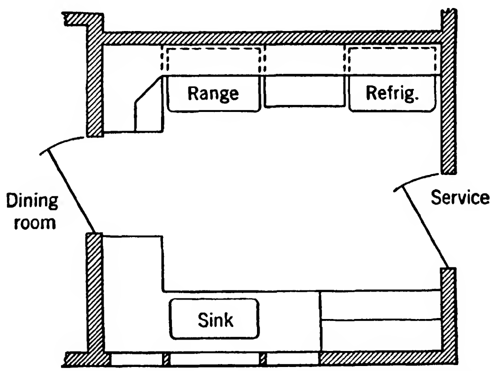
FIG. 176. U-kitchen with breakfast bar.



Art Metal Construction Co.

FIG. 177. L-shaped kitchen.

sarily have to be placed between the range and refrigerator, but these three appliances should be so related to each other as to save steps



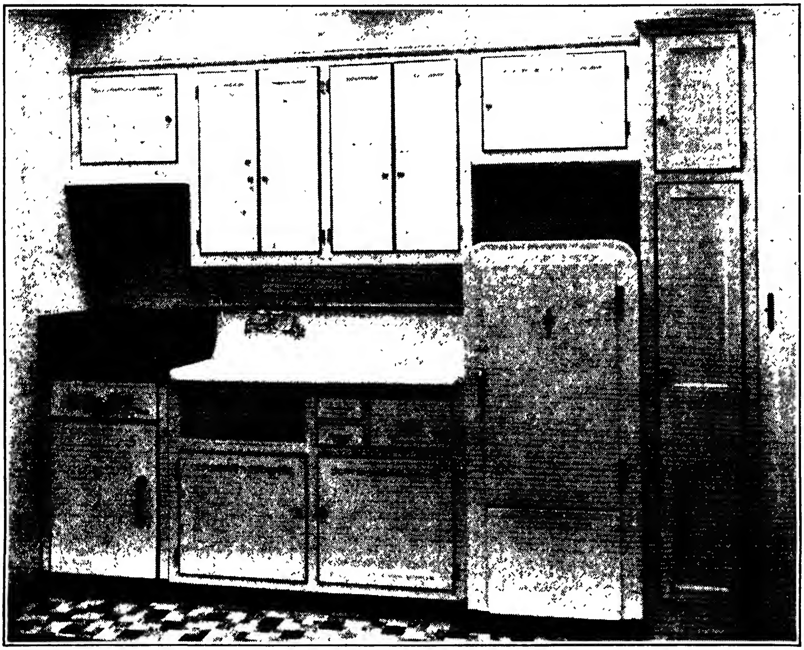
Peoples Gas Light and Coke Co. (modified)

FIG. 178. Two-wall kitchen.

in the kitchen. Mundell found that refrigerator to range travel was more frequent than refrigerator to sink. These three essential pieces of equipment are located at the points of an almost equilateral tri-

angle, with storage cabinets and continuous work surfaces between, bringing all together in an efficient unit. If service and dining-room doors are reversed, the positions of range and refrigerator would be interchanged.

If a refrigerator with a left-hand door swing is desired, it must be specified, since 90 per cent of refrigerators on the market have the right-hand swing.



American Gas Assoc.

FIG. 179. One-wall kitchen.

The L-shaped kitchen is illustrated in Fig. 177. Again the sink is between refrigerator and range. The free side of the room may be used for a breakfast table, or a breakfast bar if the available space is small, or extra cabinets may be built against the unoccupied wall.

When doors are at either end of the kitchen, arrangement of equipment on both walls is essential. A suggested layout is given in Fig. 178. In the very narrow kitchen, usable space is reduced to one wall. (Fig. 179.) Doors sometimes break into the perfect U or L arrangements, and when the walls are divided into short spaces it may be necessary to plan each center as a separate unit. Since areas will vary in size, no two kitchens of this type will be exactly alike.

Preparation center

In the preparation center are cabinet or table, with storage cupboards for needed staple supplies and utensils, a refrigerator for perishables, and ventilated bins for fruits and vegetables not requiring refrigeration. (Fig. 180.) Supplies are brought in through the service entrance; a shelf near this door where the homemaker may place the

Lenore Sater Thye, BHNHE, U.S.D.A.

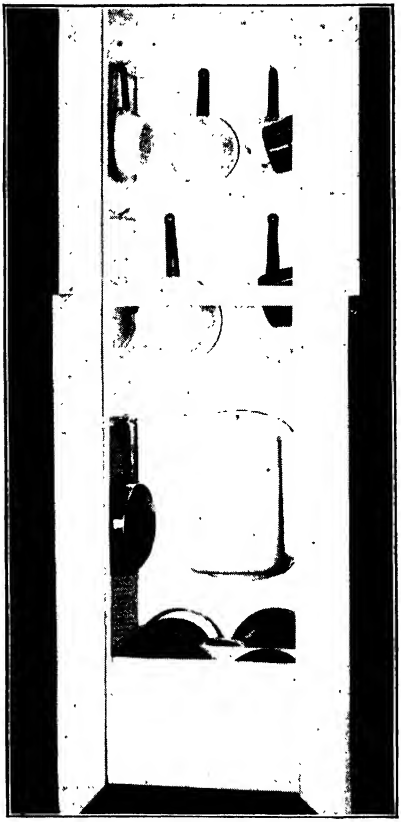
Fig. 180. With vegetable bins in front, sink at left, knife rack at right, and garbage hatch in counter, the cook has a step-saving setup for preparing vegetables.

foods is a convenience. She may then distribute the various items to correct locations to eliminate retracing of steps during meal preparation. Built-in coolers may be used for the more bulky, less perishable foods, which do, however, need to be kept cooler than the average kitchen temperature permits. In certain sections of the country where weather conditions are favorable, these coolers are extensively used for eggs, butter, and other foods commonly refrigerated.

Cooking and serving center

The cooking and serving center contains the range and some kind of serving table, which may be either stationary or movable. In addition there should be a cupboard for frying pans and saucepans, with a rack for lids, and a nearby storage place for seasonings, pot holders,

and the knives, spoons, and other serving equipment used at the range. (Figs. 181 and 182.) Some homemakers prefer to have a shelf above the range for coffee, tea, and condiments with hooks below for utensils. A box or drawer for bread may be placed below or at the back of the serving counter, and a cabinet above may hold platters and other serving dishes.



Roberts and Mander Corp.

FIG. 181. Pot and pan cupboard.

To shorten the work of serving, this center should be near the dining room unless a coal or wood range is used. Whenever possible the solid fuel range is placed near the door to cellar or outside, to save steps and eliminate dirt in the bringing in of fuel and the removal of ashes.

Cleaning center

The cleaning or clearing-away center has a stack counter, with refuse receptacle, sink and drainboard, perhaps a dishwasher, and cabinets for the dishes. (Figs. 174 to 176.) The counter is at the right of the sink, or the right-hand drainboard of a two-drainboard sink may hold the stacked dishes. A single drainboard should be at the left of the sink, unless the housekeeper is left-handed. Utensil and china cabinets may be built at either side of the sink or even above it. When the cabinet is above the sink, the sink should project at least 12 inches beyond the cabinet and there should be a clearance of 30 inches between the bottom of the sink and the cabinet; with the cabinet shelves 8 inches apart, dishes may be placed on the first two shelves without the use of a stool and without uncomfortable stretching. Such a location for the cabinet reduces walking to the minimum.

When china is to be kept in a cupboard at one side of the sink, the side chosen is a matter of personal preference. If the cupboard is at

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FIG. 182. An exceptionally well-planned cooking and serving center. Note file for pan covers, serving dishes, and platters. Packaged foods to be kept dry and crisp are stored above range.

the left of the sink, the dishes may be placed in it as they are wiped without extra steps; if at the right, some steps must be taken, and probably some extra handling will be required, but the china may be nearer the dining room when needed again for the table. Some investigators suggest building the dish cabinet on a party wall between kitchen and dining room, with openings into both rooms. This undoubtedly saves steps in setting the table, but many homemakers find that such built-in cupboards detract from the appearance of the dining room and prefer to keep all but perhaps some unusually lovely pieces of china in the kitchen. When the kitchen is carefully arranged and a serving cart or tray is used for trips between kitchen and dining room the difference in amount of energy used in the two arrangements probably is negligible.

Routing

A right-handed person uses fewest movements if she washes her dishes from right to left. The dishes are stacked to the right of the dishpan, placed in the pan, washed, set on the drainboard to the left of the pan, wiped, and placed on a table to the left of the drainboard.

In preparation and cooking and serving centers, one may work from right to left or left to right with equal convenience so long as the processes end at the dining-room door, but it has been found that maximum efficiency is attained if the work is progressive with little or no retracing of steps. Since the clearing-away center is arranged for work from right to left, the work carried on in the other centers would seem to fit in with this arrangement most satisfactorily if also routed from right to left. Actual experiment has proved this to be true. All floor plans show how the fewest steps are taken in routing the meal from refrigerator and preparation counter to range, serving table and dining room, and back to storage cupboards. Equipment is placed close together wherever possible to give a continuous work surface.

Small equipment

Work may be made easier in any kitchen by having small equipment near the place where it is to be used: vegetable brushes and paring knives at the sink; bowls, measuring cups, egg beaters, spoons, and a spatula at the food-preparation table; skillets and saucepans, with their covers, and salt and pepper shakers at the range; serving dishes near the serving table. The serving table is a good location for the bread box and slicing knife. Duplication of some equipment may occur, but

these small appliances are so relatively inexpensive that it is advisable to purchase several of them if possible. Someone has suggested that knives, spoons, and measuring cups used in the various activity areas should have distinctive-colored handles so that they may always be returned to their proper location, a necessary procedure if the efficiency of the kitchen is to be maintained at its initial level.

Storage cabinets

A sufficient number of storage cabinets conveniently placed and arranged makes it possible for the homemaker to have everything with which to work within easy reach. It is a good rule to store supplies and equipment at the place of first use and to store together those things that will be used in one process.

Kitchen planning specialists suggest that 6 square feet of shelf space be provided for each member of the family, but not less than 18 square feet total. In addition 12 square feet of shelf space should be allowed for entertaining and the "accumulations" which occur in all families.

Cabinets are divided into three types: wall, base, and broom or pan closets. They may be separate units or be built into the kitchen as an integral part of the three centers. If built in, the unit should extend from floor to ceiling, thus eliminating the necessity of dusting the cabinet top or having to clean the floor beneath. A cabinet top not over 7 feet above the floor is recommended. In present-day construction the space above wall cupboards is "furred down," i.e., blocked in to this height, so that all shelves are readily accessible. (Fig. 186.) When there is an upper section beyond comfortable reach, it may be used for the storage of utensils required only occasionally—during the canning season, or when roasting the Thanksgiving turkey. Sometimes top shelves have separate doors; such an arrangement keeps the equipment stored there more nearly free from dust.

The building industry and some equipment manufacturers have sponsored a coordinated plan to use a "module" of 4 inches as a basis for all structural measurements. Such a plan makes it possible to standardize commercially made cabinets and work surfaces. For example, base cabinets are made 32 inches high on a 4-inch base for toe space, giving a work-counter height of 36 inches. A 16-inch clearance is allowed between counter and wall cabinet. This much space is necessary to accommodate a food mixer. The wall cabinet may be 28 inches high with 8-inch clearances between shelves. Single cabinets, both base and wall, are made 20 inches wide; double cabinets, 36 or 40 inches.

Sometimes a structure 4 to 6 inches wide is inserted behind the base cabinets. This piece is extended about 6 inches above the work surface, and the top of it forms a ledge for holding seasonings, spices, and similar small containers. (Fig. 183.) Such a construction causes the base cabinets to extend farther from the wall and permits wall cupboards to be built a shorter distance above the work counter. Sufficient space must be left, however, to allow the homemaker to work with ease and open doors without moving any equipment; other-

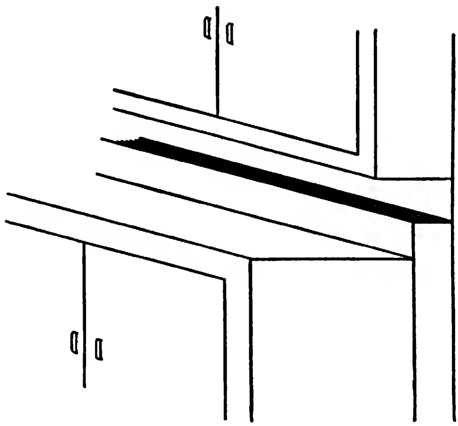


FIG. 183. A type of construction used to extend the base cabinets farther from the wall.

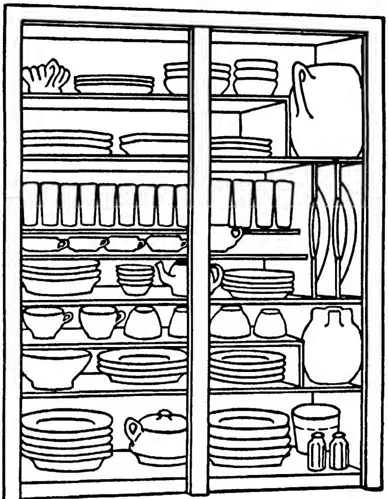
wise the doors should be sliding. When wall cabinets are built above the range, a 22-inch clearance should be allowed; above the sink, a 30-inch clearance.

Whatever the type of cabinet, shelves should be near enough together to prevent waste space and of a depth to allow dishes or utensils to be stored in single rows easily accessible without bending or reaching. Shelves 12 inches deep and 8 to 12 inches apart provide storage for ordinary dishes and utensils, a wider space being left for larger kettles and saucepans. Often it is preferable to hang utensils instead of stacking them. Adjustable shelves are recommended. They are, however, somewhat more expensive than stationary ones.

Shallow cabinets 6½ inches deep with a 6-inch clearance between shelves will take care of tumblers, cups and saucers, small pitchers, bread-and-butter plates, salts and peppers, and the numerous small items that clutter up the large cabinet and hinder its efficient arrangement. If a separate cabinet is not possible, narrow shelves can be

built between the deeper ones to hold the smaller items. (Fig. 184.) Sometimes cut-back shelves in the cupboard for single-line storage and racks on the inside of the cupboard doors solve the problem. The shelves should be the right size to fit the articles to be stored.

Spices, seasonings, extracts, and baking powder may occupy a narrow open shelf above the preparation counter or a series of step shelves 2 inches deep built on to a cabinet shelf. (Fig. 185.) Some



Kitchen Reporter

FIG. 184. Maximum storage capacity can be obtained by building half-shelves between the wide ones.

FIG. 185. Spices stored on step shelves are always in sight.

new types of cabinet construction install a narrow closed cupboard with a roll-up door below the wall cupboard. (Fig. 186.) The most frequently used items should have the most accessible location.

A variety of materials may be used for counter finish: wood, tile, zinc, aluminum, stainless steel, Monel metal, porcelain enamel, oilcloth, linoleum, rubber tile, and composition materials such as Micarta. Heat-treated glass and bonded plastic on plywood are among the newer materials on the market. They are made clear and in colors. Flexboard, a combination of asbestos and cement, and Tempered Presdwood are also available. Select a kind that is non-absorbent, will not spot or stain from the usual household acids, alkalies, or greases, will stand up under the abrasives commonly used, will not scratch, will not be affected by heat, will eliminate noise, and will give reasonably long service.

In the following paragraphs several of the materials are discussed in some detail.

Acid-resisting porcelain enamel finishes are formed by fusing a thin coating of a special glass composition to an iron or steel base, at a high temperature. The metal base provides strength and workability, and the glass provides a smooth, non-porous, colorful surface.

Acid-resisting porcelain enamel is unaffected by fruit and vegetable juices or by alcohol. It is impervious to the heat of scalding water, and

Gas Service Co.

FIG. 186. An L-shaped kitchen. Note small cupboards with roll-up doors either side of range.

hot dishes will not mar it. Its glass-smooth surface makes it easy to clean and keep clean. Because of these qualities and characteristics, it makes an attractive and durable finish for sinks, drainboards, table and counter tops as well as ranges.

Linoleum work surfaces are durable, colorful, resilient, quiet to work on and easy to clean and maintain. Because of these desirable qualities, a number of manufacturers of steel equipment are using heavy linoleum as work surfaces for cabinets and sink tops. The linoleum is cemented to a steel base to prevent warping, and the edges are bound with a stainless steel molding. The crack at the rear is covered with a stainless steel cove molding or with a coved back-splash of stainless steel. The linoleum itself may be continued to form a back-splash, thus eliminating a seam at the bend.

When cabinets are built of wood, the linoleum may be cemented directly to the work top and the edges finished with steel molding. The ease of installation and the range of widths of linoleum make it possible to cover almost any work surface without cracks or crevices.

The homemaker who desires a colorful kitchen will find it easy to carry out any color scheme she prefers if linoleum is used for work surfaces. Plain colors and marbleized patterns are restful to the eyes, and both make very attractive work tops. It is generally thought, however, that patterned linoleums require less care than plain ones.

Stainless steel work surfaces are strong, durable, attractive, heat resistant and easy to clean and maintain. The smooth, silvery stain- and acid-resisting surface of this metal makes it a very desirable finish for both sinks and counter tops in the kitchen. It is used by many manufacturers of steel kitchen equipment, and it may also be shaped and fitted to work tops of wood.

The color of stainless steel is restful to the eyes, and it may be combined most successfully with other colors and natural woods.

Monel metal, which is the trade-marked name of an alloy of copper and nickel, makes a durable finish for counter tops. It is acid- and heat-resistant and retains a bright, metallic surface with minimum care. It is lighter in color than stainless steel, and its surface has a smooth, lustrous appearance.

Tile work surfaces are made of small, flint-like ceramic tiles, which are durable and non-absorbent. A tile surface is somewhat noisy to work on, and unless care is taken, it tends to chip dishes. However, because it is impervious to water, it is especially suited for work surfaces adjoining the sink.

Tile is made in a variety of colors and textures. It may be used in a solid color, or several colors may be combined to form pleasing patterns.

Heat-treated glass is one of the newer materials for counter tops. This tempering process increases the strength and resistance of glass to shocks and temperatures so that hot dishes may be placed on it without danger of breakage. The hard surface of glass is impervious to grease and water, and it is, therefore, easy to clean. It is exceptionally resistant to abrasion and surface scratches, and for this reason, makes a serviceable work surface at the mixing center, where such operations as cutting and slicing fruits and vegetables, rolling pastries and cookies, and kneading doughs are performed. When only a small work area of glass is preferred, a piece may be cemented to the top of the work surface, or set in, and firmly cemented in place. Heat-treated glass is available clear, and in a variety of colors.

Wood counter tops made of well-seasoned, smooth-surfaced wood and treated with oil, or covered with waterproof varnish, make attractive work surfaces. Wood, however, is absorbent, needs frequent refinishing and requires far more care than the other more easily cleaned finishes.

The most serviceable woods for work counters are maple and birch, both hard, close-grained woods. White pine, which is a much softer wood, makes a good working surface, but it gives better wear if it is finished with waterproof varnish or a coat of paint.

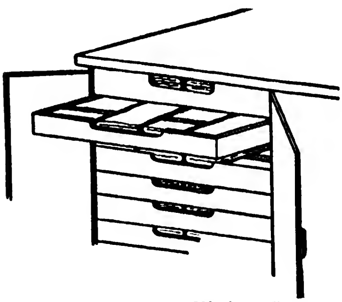
Flexboard, which is made by combining asbestos and cement under high pressure, makes a very durable and inexpensive work surface. It is smooth,

heat-resistant and easily cleaned and may be waxed or varnished. This material was designed for use on laboratory walls and ceilings, but it serves equally well for work surfaces in the kitchen.

Tempered Presdwood is made by impregnating the standard Presdwood sheet with a special tempering liquid and then polymerizing the liquid by baking. This process produces a board that is smooth, hard, and moisture-resistant. Special sealing compounds are available which make the surface practically non-absorbent. In its natural state the color of Presdwood is rich, mottled brown; however, it may be stained or painted to harmonize with any color scheme.

Rubber composition work surfaces are resilient, non-absorbent, and easy to clean. The sheets of this material are flexible and can be easily shaped and cemented to any work counter.[1]

Appearance and sanitation are improved if the counter covering is continued over the union between wall and work surface, forming a backsplash several inches high, or it may be extended to the base of the wall cabinets.



Kitchen Reporter

FIG. 187. Shallow drawers are preferred for storage of linens and aprons.

Base cabinets may be fitted with drawers or cupboards. Shallow drawers are more suitable than deep ones for the storage of linens, kitchen aprons, and small appliances not easily hung from hooks. (Fig. 187.) Partitioned drawers are needed for cutlery. Drawers should slide smoothly, never bind or sag. In cupboards, it is an advantage to have pull-out shelves so that any piece of equipment may be plainly seen and easily removed. Some cabinet manufacturers are making these sliding shelves of open bars or heavy wire to increase visibility. A revolving platform, commonly called a Lazy Susan, in a corner cupboard increases storage capacity and brings all items within easy reach. (Fig. 188.) Bins built below the counter should be counterbalanced or should be constructed as separate units on casters so that they may be wheeled to any position in the kitchen. Bins for the storage of non-refrigerated fruits and vegetables should be ventilated.

A cabinet or drawer divided into sections offers the most satisfactory storage for trays, muffin tins, pie plates, and cookie sheets.

[1] Jean Muir Dorsey, Choosing Kitchen Work Surfaces, *The Kitchen Reporter*, 1946.

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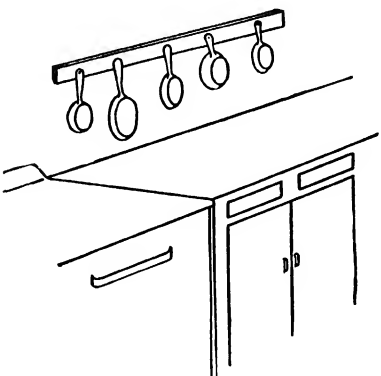
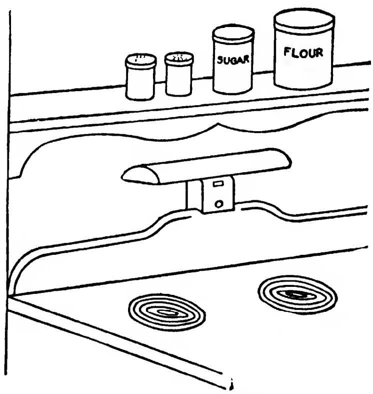
FIG. 188. Preparation center with utensils stored at place of first use. The revolving shelves bring supplies within easy reach.



Kitchen Reporter

FIG. 189. Some homemakers prefer to hang pans on the wall above or near the range.



Kitchen Reporter

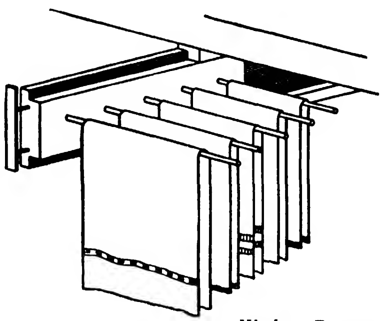
FIG. 190. A shelf above the range holds frequently used supplies.

N. Y. State College of Home Economics

FIG. 191. Vertical sliding drawers keep stewpans in order. Notice that the pulls on these drawers are placed where the worker can grasp them easily.

Either a base or a wall cabinet may be so divided. The partitions should be removable for ease in cleaning. (Figs. 181 and 188.)

Whether all kitchen utensils should be kept in cabinets and drawers or should in part be hung near the place where used is a matter of choice. (Fig. 189.) Advocates of time and energy saving recommend a shelf above the range for seasonings and for coffee, tea, and the pots in which they are prepared. (Fig. 190.) Below the shelf are hooks for saucepans, ladles, pancake turners, long-handled forks and dippers, and pot holders. A nearby rack holds butcher and carving knives. Some homemakers, especially those living near unpaved service areas or roads where dust is a problem, prefer to keep all utensils under cover. A pan cupboard, 6 or 7 feet high, near the range may be fitted with hooks for utensils and serving appliances. A rack on the door holds lids. Sometimes this cupboard is a part of the base-cabinet installation. A vertical section attached to a front panel affords space for the hanging of saucepans and similar articles. (Fig. 191.)



Kitchen Reporter

FIG. 192. Dish towels may be hidden from view in a base cabinet.

Cabinets or closets for cleaning equipment such as the electric cleaner, mops, brooms, dust cloths, and waxes and polishes are also usually 6 or 7 feet in height, with one or two doors and a combination of shelves and hooks. (Fig. 173.) The cleaning cabinet may be built in or purchased as a separate unit. It should be placed in the back hallway, if space permits, or near the outside door to save steps when emptying dust containers and shaking mops and cloths out of doors. The cleaning cabinet sometimes interferes with routing of work, a difficulty eliminated by the cleaning-equipment "pocket" fastened to a door. Dishwashing utensils, soaps, and scouring powders are stored at the sink. A shelf below the sink for these articles may be concealed by a latticed door, which gives the needed ventilation. A towel rack in the cabinet beneath the sink improves the appearance of the kitchen, but here, too, adequate ventilation is essential. (Fig. 192.)

The flush panel is preferable for cabinet doors, for it has an unbroken surface, easier to clean than the indented panel, although

somewhat more expensive. (Fig. 186.) All doors should be hinged in such a way that they will not interfere with one another, with other pieces of equipment, or with the worker. Cupboard doors should not be so wide that they will swing out beyond the edge of the work counter. Two narrow doors occupy less space when open than one wide one. As a rule, single doors should open away from the direction from which they will be most frequently approached. Hinges should be partly or wholly concealed. All hardware used in cabinet construction should be non-tarnishing and of the highest quality. Toe space should be left at the floor to allow the worker to stand with comfort. Minimum dimensions of such a space, determined in the Washington-Oregon investigation, are 4 inches front to back and 3 inches vertically. Table tops on standard kitchen cabinets purchased as complete units usually slide out, giving ample knee space for the person wishing to use a stool. If cabinets are built in, open space may be left beneath one section of the counter.

Pantry

The compact grouping of storage space in the kitchen saves steps, time, and energy, so that many of the more recently built homes do not have a pantry. In some homes, however, pantries are still a necessity, and they are recommended whenever placing the additional storage space in the kitchen would make it too big for efficient arrangement. If the family is large or if much entertaining is done, extra space will be needed. Expensive homes often have a "butler's pantry" between the kitchen and dining room, with cabinets for the more costly china and glassware, and a separate sink where these dishes may be washed. Below the cabinets there is drawer space for the fine linens. Pantries are common in farm homes so far away from town supplies that flour, sugar, and other staples must be kept in large amounts. The use of many home-produced foods may also require additional storage space. Earlier homes were built with pantries, and many of these pantries are still used, but in some instances the kitchen has been remodeled, cabinets have been built in, and the pantry converted into a breakfast alcove.

Working heights

Heights of work surfaces should be adapted to the height of the homemaker. Such operations as kneading, mixing, and stirring put a strain on the shoulder muscles. Work at too high a counter causes the elbow to bend and the shoulders to lift, resulting in increased

tension in the small muscles and fatigue. Work at too low a surface causes a person to stoop, a position which tires the back muscles.

As a result of tests Mason found that workers whose heights varied from 5 feet 2 inches to 5 feet 8 inches selected working heights between 32.33 and 33.80 inches, an average of approximately 33 inches. A study carried on cooperatively by the Washington and Oregon Agricultural Experiment Stations gave similar results. The average homemaker preferred a counter 32 inches high and a sink whose floor was 32½ inches above the kitchen floor. Older women, however, tended to select heights somewhat above the mean for the group. It is necessary to use some such average in building cabinets and table surfaces into homes that will be occupied by changing tenant families.

The practice in modern kitchen layouts of having all surfaces on a level, using the 36-inch height of the range as the unit of measure, places more emphasis on appearance than suitability. Different tasks performed in the kitchen frequently require work surfaces of different heights, but this variation is not always available. Knowles' study of working heights indicated that the height is correct if the worker can stand with ear, shoulder, hip, and ankle in a perpendicular line and still reach as far as necessary without bending forward. Alternate standing and sitting reduce fatigue and are possible if the height of the chair is properly adjusted to the height of the work surface. Correct sitting heights keep the arm in relatively the same position as in standing at work. When a chair or stool does not do this, it should be raised on blocks or a small platform, or be lowered by cutting off the legs. If such an arrangement does not allow the feet to rest on the floor, a foot support must be provided.

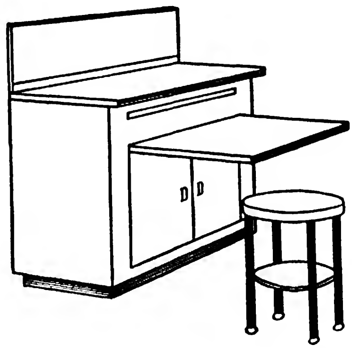


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FIG. 193. A sliding shelf will allow the worker to sit at her task.

The practice of building in a sliding shelf or lap board makes it possible to sit for many, perhaps the majority, of kitchen tasks. (Fig. 193.) A bread board placed on the top of an opened drawer provides such a surface. It also affords a place to attach a meat grinder, a frequent lack in many modern kitchens, or the grinder may be screwed to a wooden block fastened over the counter edge.

Similarly, work surfaces which are themselves too low may be raised by casters or blocks beneath the legs, or the utensil may be placed on a rack or tray. Surfaces that are too high may be lowered by cutting off the legs, wherever possible, or the worker may stand upon a platform.

Suitable heights for shelves may be found by measuring the height to which the housewife can reach with comfort; she should be able to reach to the middle of the shelf rather than merely to the front edge. Stretching over a work surface shortens the extent of reach—by 3 inches when the counter is 12 inches wide, and by 10 inches when it is 24, according to Wilson and Roberts, who carried on the Oregon-Washington project. Some authorities place the top cabinet shelf 6 feet from the floor, a location which they have found to be the maximum height accessible without the use of a stool.

Clearance space

Although 4 to 6 feet of clearance space is considered desirable in the average kitchen, the space needed depends upon the circular size of the worker and upon the type of perpendicular surfaces opposing each other. If the oven door is hinged at the bottom to form a shelf, if cupboard doors swing outward, or if there are drawers, and the opposite piece of equipment has a solid front, more clearance space is needed than when the opposite piece of equipment is a work surface with an open space beneath. The worker should be able to move and stoop with ease. And what is comfortable for one person may not be for another.

Shape

Most kitchens are square or rectangular, but some are irregular in shape. Except for the very small kitchen, the rectangular type seems to permit the most efficient arrangement. Equipment is customarily placed against the walls. When the central clearance between the pieces of equipment is 5 feet, one or even two adults may work without troublesome interference and with the fewest unnecessary steps. Thirty inches is the least clearance advised for one adult, and this amount is scarcely adequate unless careful attention is given to the hinging of cabinet, refrigerator, and range oven doors. A clearance of more than 5 feet requires unnecessary walking from one work center to another. This fact may be made clear by considering two kitchens, each with a floor area of 144 square feet. One room is 12 feet by 12 feet, the other 9 feet by 16 feet. Although equipment

varies somewhat in width, the average width is about 2 feet, so that an allowance of 2 feet on each side of the kitchen should be adequate; the equipment on one side will lack in width what the equipment on the other side needs. In the 12-foot-wide room there will be a clearance of 8 feet; in the 9-foot room, of 5 feet. Three feet of space are worth considering in an attempt to reduce the fatigue and so increase the efficiency of the housewife.

Mary Koll Heiner has pointed out that "efficiency ceases when fatigue begins," with these resulting effects: "first, a decrease in the power to do work; second, a decrease in pleasure taken in work; and third, a decrease in enjoyment away from work." [1]

In an L-shaped kitchen—do not confuse shape with arrangement of work areas—the number of steps taken may be reduced by grouping the work centers toward one end of the L and using the other end for a breakfast alcove, or for laundry equipment when laundry must be done in the kitchen.

Appliances are most efficiently arranged in a small kitchen when it is square, for the worker may stand in the center and reach equipment on all sides, but, when the small kitchen is rectangular in shape, only one side may be used and more steps must be taken.

Position and number of openings

Each kitchen has doors and windows, which not only affect the amount of natural light available and the ease of ventilating the room but also noticeably influence the arrangement of the work centers. The kitchen should have, if possible, at least two outside walls. Windows may then be placed on two adjoining walls, giving a well-lighted room and cross ventilation. Window area should equal about one-fourth or one-fifth of the floor area and should not be sacrificed to provide space for built-in cabinets, a point frequently overlooked by the modern designer, who apparently presupposes air conditioning or at least a ventilating fan in every kitchen.

When the installation of a fan is possible it will occupy much less wall space than a window, since it may be placed above a cabinet or even in the ceiling.

The windows should be high enough above the floor to allow the placing of equipment beneath them. Most sinks and ranges will fit beneath a window sill 44 inches from the floor, and a new sink has a back only 4 inches above the 36-inch rim. Windows should not be

[1] Mary K. Heiner, *This Business of Housekeeping*, p. 6.

built within 15 inches of any corner, so that wall-cabinet construction may be continued into the corners of the room. For the sake of the outside appearance of the house the tops of all windows are the same distance from the floor.

There is some question as to the advisability of having windows directly over the sink. Light transmitted by high windows is reflected largely from the sky, and sky light is frequently more than twice as bright as light from the ground. Such windows facing the worker may, therefore, cause glare, which is to be avoided at all times. A porch or awning will reduce the intensity, or windows may be built over the drainboards instead of over the sink. A window or windows in the wall to the left of the sink give a very satisfactory light. When windows are on only one side of the kitchen and an outside door is on the adjoining wall, light may be increased by having a pane in the door. Walls of glass bricks also improve the daytime lighting of the kitchen.

Windows should be curtained with sheer material such as scrim or a better grade of cheesecloth, made simply without ruffles for ease in laundering. The present tendency is to use fadeproof cottons to match the color scheme of the kitchen. Plastic materials are also available but are not easily pleated or gathered. Some varieties become sticky near heat, and others are definitely a fire hazard.

The window treatment should be a part of the decoration of the kitchen. Curtains should fit the window; a broad window may acquire an appearance of height if the curtains have vertical stripes and are hung straight; a narrow high window should be curtained with the stripes horizontal. Cool colors are suggested for summer curtains, warm shades for winter. Curtains should frame the view, not obscure it. When one rents or buys a house already built, there is little choice in the outlook from the kitchen windows, but, if choice is possible, let the view be attractive and interesting and let the windows overlook a suitable playground for the children.

Plants and bright painted cornices also add to the decorative scheme. Potted herbs have a double value, both for fragrance and for flavor.

Most kitchens have at least two doors, many of them three or four. Doors more than windows prevent efficient grouping of equipment, making impossible a continuous work surface. The number of doors may be reduced to two by having one open into a back hall from which there is access both to the outside and to the cellar. Such an arrangement also decreases the tracking in of dirt. Sometimes a door

into a playroom off the kitchen saves the steps of the mother with small children, and a door into a hall connecting directly with the front door is a convenience in answering a door bell. When more than two doors seem necessary, group them toward one end of the room to save cutting into the wall space.

The dining-room door may be hinged so that it will swing in either direction, an arrangement that prevents a too direct view of the kitchen. It is preferable not to place a kitchen door or window directly opposite the dining-room entrance, lest undesirable odors be blown into the room. The doorway to the dining room must be wide enough to allow a teacart to pass. The service door should open in such a way as to protect the work areas from draft. All kitchen doors should provide sufficient clearance to prevent interference with equipment.

Artificial light

Artificial light is necessary morning and evening for several months of the year in all temperate climates, the amount depending upon the location of the home and the percentage of dark days. The kitchen is the homemaker's workshop and requires careful lighting. A fixture near the center of the ceiling, with a surrounding opal glass globe to diffuse the light evenly, eliminates shadows and supplies general illumination. In addition to the central fixture, separate lower lights over sink, work table, and range increase efficiency by giving added illumination where it is needed. Standards specify a level of 5 to 10 foot-candles of light from the central fixture for general illumination and from 40 to 50 foot-candles of light on the work areas. Desirable types of fixtures for lighting the kitchen are discussed in the chapter on home lighting (p. 382). Daylight lamps make it possible to see meats and vegetables in natural colors, but they are not recommended for general use because of their low light output. When kerosene or gasoline is used, bracket lamps, with a metal reflector behind or above the chimney to direct the light, may be located at the work centers.

Ventilation

Doors and windows are commonly used for ventilation. Windows that extend almost to the ceiling may be opened at the top, permitting odors and steam to pass out. New homes frequently have shuttered ventilators through which a fan sucks the vitiated air. An opening near the floor allows fresh air to enter. The openings may be closed

manually when the fan is not operating, or they may close automatically with the shutting off of the fan.

The fan removes not only the warm air but also the volatile fat particles given off in the cooking processes. Cooking produces heat, odors, moisture, and greasy vapors regardless of the type of fuel used. These substances will be vented into the outer air provided the ducts leading away from the fan are short; otherwise occasional cleaning of the ducts will be necessary. The fan itself is usually of the blade type although the blower type is considered more efficient and is quieter in operation. The fan motor should be totally enclosed to prevent dirt from accumulating on the parts. The motor may need lubrication. Directions for the kind and amount of oil to be used and the frequency of application should be followed.

Since humidity hinders the evaporation of perspiration from the body, it is more enervating to the worker than heat. Even a small, inexpensive electric fan that keeps the air circulating greatly reduces the fatigue of the worker. A hot, humid kitchen is not suitable as a place for the eating of meals or as a playroom for children. New gas and electric ovens are so well insulated that heat from baking is reduced to the minimum, and the warm vapors from the oven vent or from surface cookery may be prevented from spreading through the kitchen by building a flue-connected hood over the range.

With this type of construction the heat and volatile products are removed at the source. The American Gas Association recommends building such a vent behind the storage cabinet above the range. The odors and heat rise from the range in a stream of warm air and are carried away by a blower placed at the top of the duct. (Fig. 176.) A similar vent is concealed behind a cupboard built over the gas refrigerator. In this case the warm air is directed through a grille at the top of the cupboard and is dissipated into the kitchen. Cabinets so heated may be used for the storage of dry cereals, crackers, and similar foods that the homemaker wishes to keep crisp.

Size

The size of the kitchen will depend primarily upon location and the type of home, and the type of home will in turn depend upon the income of the family, whether or not outside service is employed, the number in the family, age of the children, standard of living, and the purposes for which the kitchen is used. Nevertheless it is probably true, as Carter concludes, that "kitchen sizes are largely 'accidental,'" and that "research work is needed to establish the most suitable size

or group of sizes—based upon the equipment needed, and the operations or activities carried on in the kitchen."[1]

Some specialists believe that the kitchen with sufficient wall area to furnish 6 square feet of storage per person in wall cabinets, with space for two added to allow for entertaining, is an efficient size to care for all needs (p. 317).

The kitchen in the small city apartment usually provides only for serving of breakfast and other occasional meals which are simple and easy to prepare. More elaborate meals are eaten outside the home. Suburban and town kitchens are larger, and village and farm kitchens several times the size of the kitchens in city apartments. In towns and on farms meals are rarely eaten away from home and not infrequently there are invited guests, even when the homemaker has no additional help. Where a maid is alone in the kitchen the usual clearance for a single worker is allowed.

The number in the family and the age of the children have a definite influence on the size of kitchen required. If the children are small they may need to be in the kitchen for part of the time where the mother can keep an eye on them while she is doing her work. When there are excessive heat and steam this is far from an ideal arrangement. More clearance space between pieces of equipment is required when children are partly grown and one or two daughters assist the mother in the kitchen tasks; and, where the kitchen is also the dining room and sometimes, for part of the year at least, even a general living room, as in many of the rural homes, it must be large.

Kitchens of the various types will be discussed in somewhat more detail in the following pages.

Apartment kitchens

The kitchen in the one- or two-room city apartment may be of the wall or alcove type. Although a minimum of steps is taken with any appliance arrangement in kitchens of this class, placing the sink between range and refrigerator gives greatest efficiency. (Fig. 179.)

The wall kitchen is usually about 6 or 8 feet long and allows for 24 to 26 inches of clearance space in front of the equipment. In order for this space to be sufficient, storage-cabinet and utensil-compartment doors must be narrow and hung to swing without blocking each other or interfering with the worker. As an alternative, sliding

[1] Deane G. Carter, *Studies in the Design of Kitchens and Kitchen Equipment*, p. 11.

doors may be used. Mechanical refrigeration is installed if possible, to eliminate the services of the ice man; many wall kitchens do not border on a hall to permit outside icing. The refrigerator is built under the work table or even under the range to conserve space, modern methods of insulation making this possible. The range oven is frequently located above the burner plate, or a separate oven is used. Cabinets for china, utensils, and staple supplies are built above sink and work table, with drawers and a ventilated fruit or vegetable bin below. A closet 6 inches deep with a shelf for cleaning supplies and hooks for broom, mop, etc., may be fastened to the inside of one of the doors. Oiled mops and dust cloths are often used, so the closet and the door against which it is placed should be of fireproof material. Since the wall kitchen opens from the dining room or combination living-dining room with sliding or folding doors, some efficient means of ventilation must be provided. There are usually no windows, but connection with a ventilating shaft near the ceiling should be made.

In the kitchenette combined with dining alcove, space is conserved by building together range and refrigerator, sink and china cabinet, and work table, vegetable bin, and supply cupboard. Usually the equipment occupies three walls instead of a single one, with a 30-inch clearance space as the minimum. Here again ventilation is essential. Windows are at the end of the dining alcove, but there should be a vent with exhaust fan over the range in the kitchenette.

Kitchenettes 4 to 6 or 7 feet square may have equipment grouped on two or three sides in as efficient combinations as possible. Cupboard doors in the smaller kitchenettes will frequently interfere with each other, no matter how carefully planned, and open shelves are necessary. Increased work surface may be obtained by having a table hinged to the door on the kitchenette side. This table may be let down into the dining room when the door is open, and used as needed. The person working in such a small square kitchen may stand in the center and without any steps reach equipment on the two or three walls, against which it is placed.

Rural kitchens

A direct contrast to the miniature kitchens which have just been discussed are the large kitchens in farm or small-town homes. In many states rural homes are still in the majority. Here the kitchen is still the most important room in the house. If the average homemaker spends 45 to 50 per cent of her working hours in the kitchen, the mother on the farm must spend a much larger percentage of time

there. Around it centers the family life, not only because it is the scene of extensive food preparation upon which the health and happiness of the family depend, but also because of the social life carried on there. During the colder months and often throughout the year, many of the meals may be eaten here. The dining area in the rural kitchen must, therefore, be larger than in the average urban home. The kitchen may be used for laundry operations. Outer wraps used by the men may be hung in a corner and heavy boots left on the floor beneath them. For sanitary reasons such an arrangement is not desirable, and the present tendency is to provide a utility room for such uses, with a built-in closet for wraps. When there is no bathroom or it is on another floor, it is essential to have a lavatory apart from the sink.

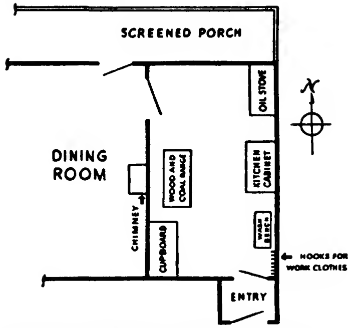
The utility room should be adjacent to the kitchen, but it should also have a separate outside entrance. It may furnish space for the home freezer and during certain seasons of the year become the center of food-preservation operations, both canning and freezing, and so remove additional clutter from the kitchen. An extra sink with a spray attachment is an advantage for cleaning vegetables and fruits. Counter space, ordinarily used for sorting of laundry, may be covered with heavy paper or oilcloth for needed work surface.

The ideal kitchen should provide first of all for the efficiency and comfort of the homemaker. A coal or wood range may necessitate a larger area than is common in urban homes but not so large as the rural kitchen often is. Hoyt, in a study of families living on Iowa farms, found that the average size of 247 rural Iowa kitchens was 171 square feet, with an average total distance connecting work centers of 37 feet. Think of the wasted energy!

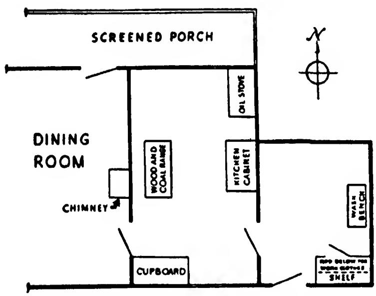
With the extension of rural electric lines, many kitchens may be remodeled to provide a smaller work area for the homemaker. The space thus freed may be used for other purposes: a snack bar, a sewing corner, or a play alcove for the children.

When the men are away from the house, attending to various duties about the farmstead, the mother is in charge and should have an unobstructed view of the service area, drives, and other buildings. The back entrance is used more frequently than the other doors, but a kitchen that serves as a passageway is a most difficult place in which to do efficient work. Cross traffic, which inevitably results when a large number of doors open into the kitchen, may be reduced by having a rear hall which gives access to other parts of the house as well as to the kitchen.

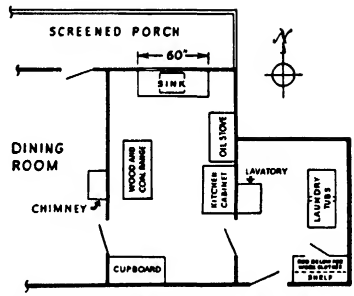
KITCHEN 9'X15'



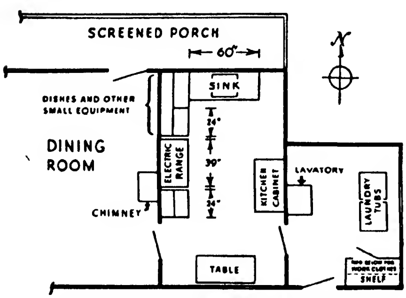
a. The kitchen before remodeling was begun.



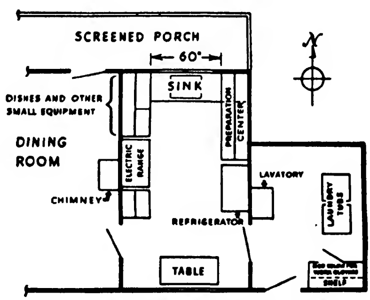
b. The kitchen at the end of the first year of the long-range remodeling plan.



c. The kitchen at the end of the second year of the long-range remodeling plan.



d. The kitchen at the end of the third year of the long-range remodeling plan.



e. The kitchen at the end of the fourth year of the long-range remodeling plan.

Kitchen Reporter

FIG. 194. Kitchen improvements over a 5-year period. The next 5 years could be used in improving the laundry setup.

A change in location of work centers or a regrouping of equipment in the centers may often do away with objectionable features and result in worth-while step saving. Figure 194 shows how a series of improvements, made gradually over a 5-year period, has increased the efficiency of the kitchen and at the same time cared for the needs of other members of the family.

Moderate-sized kitchens

Between very small and very large kitchens are those in one-family homes in the larger towns and small cities. These kitchens are usually rectangular, of moderate size, with 75 to 140 square feet of floor area.

Floor and wall finishes

Material suitable for the kitchen floor covering should be resilient to the feet, be impervious to moisture and fruit and grease stains, and have long-wearing qualities. Wood floors, even of hard wood, require frequent renewal of paint or varnish to remain in condition, and they are not resilient. Rubber or linoleum mats, placed at spots where the worker most frequently stands, overcome to some extent these objectionable features. Tile is easy to clean and offers lifetime wearing qualities, but, since it has no resiliency, it is hard to stand on for any length of time. Composition floors possess many desirable qualities but as yet are fairly expensive and not in common use. Rubber tile is resilient but requires special care in cleaning, and some varieties are spotted by grease. It is expensive. Of the various materials studied in the equipment research laboratory, linoleum proved most satisfactory. Inlaid linoleum has more lasting qualities than the printed, but either kind is easily cleaned, does not spot with any of the common household stains or greases, and is resilient. A marbleized or mottled pattern is usually a good choice since it does not show footprints. A linoleum with a felt base instead of burlap, and several other felt-base floor coverings, in which the color extends through to the felt, are on the market. Their wearing quality is fairly satisfactory; they are resilient and cheaper than linoleum. Floor coverings of these types will look better and wear longer if laid by an expert. Varieties of linoleum, method of laying, and care are discussed in detail in Chapter 1. Information on other floor finishes is also given.

Extending the floor covering against the wall to form a baseboard 2 or 3 inches high increases sanitation, improves appearance, and aids

in cleaning. Linoleum manufacturers warn against washing this floor material with hot water or strong soaps; in fact, they warn against frequent washing of any kind. Linoleum should not be varnished, shellacked, or lacquered but given a thin coating of wax. Water emulsion or self-polishing wax which contains carnauba wax is recommended. Two thin coats, applied about 30 minutes apart, are more durable and less slippery than a single thick coat. The floor should be swept frequently to prevent sand or grit from being ground into the linoleum, and the movable kitchen furnishings should be provided with large casters or cups under the feet to prevent denting it. When necessary, wipe the linoleum carefully with a damp cloth wrung from clear lukewarm water.

Wall finishes should be smooth, hard, and impervious to moisture and common stains, a requirement which rules out wall paper unless it is varnished or of the waterproof variety. Oilcloth may be used and can be obtained in many appropriate designs and colors. It should be fastened to the walls with waterproof cement to prevent corners or edges from loosening when cleaned. The adhesive-back linoleum is made in a special light weight for walls (p. 14). Tile is attractive and satisfactory but difficult to apply in old construction and too expensive for many homes. A number of imitation tiles may be placed directly over plaster; these include asbestos and composition board, painted or enameled, and a light-weight steel tile finished in porcelain enamel, which must be cemented to a foundation of Celotex. A glass that may be cemented to plaster or composition board is now available and gives an exceptionally beautiful finish, but if polished it may produce undesirable reflection. The cost is prohibitive for the ordinary kitchen. Micarta, a composition material, is also used for wall coverings (p. 15).

Painted plaster is probably the most common finish. Several coats of high-grade semigloss paint should be applied to both walls and ceilings, or the ceiling may be treated with cold-water calcimine and recalcimined when necessary. The ceiling is hard to wash by ordinary methods.

The color used will depend to some extent upon the exposure of the room. A northeast room is more cheerful if warm tints are used—buffs, creams, and warm grays; in rooms of sunny exposure, pale greens, grays, or blues are satisfactory. Colors may be chosen from those which are found in the dishes or floor covering. Two or three colors may be used or several tones of one color. Patchy areas of color should be avoided. Neutral colors are more pleasing as a back-

ground than bright unusual colors. Gay colors are, however, satisfactory for accents. The interiors of cabinets are frequently painted in brilliant shades of red, green, or blue, with the color repeated in a trimming line, in the border of a curtain, or in a bright piece of pottery on the window sill. Ketcham points out that bright colors tend to stimulate and should be used in the kitchen, the scene of so much activity.

The color of the walls very directly influences the light available in the kitchen, for different colors have different reflection factors. Some colors that reflect too much light for comfort may be used on the ceiling. A gloss finish tends to produce image reflections of artificial lights, which cause glare.

The reflection factors of a few common wall colors are given in the table.[1]

Color	*Reflection Factor, per cent*	*Color*	*Reflection Factor, per cent*
White gloss	84	Pink	72
Flat white	82	Ivory tan	67
White eggshell	81	Light green	63
Ivory white	79	Light gray	58
Silver gray	75	Buff	55
Cream	74	Light blue	54

The woodwork may be painted the same color as the walls but a tone or two darker, or in a harmonizing color. Pieces of plate glass on the doors where the hand tends to touch the paint will prevent finger marks and eliminate a lot of cleaning. Colors in the floor covering and curtains may repeat the color note suggested by the walls.

Sinks

Modern sinks are made of metal and porcelain enamel, usually with an acid-resisting finish. The enameled iron sink is the more common and is obtainable in colors. Monel metal sinks are very attractive in appearance and have insulated drainboards, which greatly reduce the noise of handling dishes. Sinks come in numerous sizes and designs, with two drainboards, with only one, or with none at all. Some of the drainboards are grooved; some are not, the flat surface giving added work space upon which bowls and pans may sit securely. An inch rim permits rinsing without danger of water slopping on the floor. The bottom of the sink slopes toward the middle or one end

[1] J. O. Dahl, *Lighting Up the Dark Spots in the Hotel's Kitchen*, p. 161.

to allow rapid and complete draining. The drain should be provided with a removable cup strainer to catch waste particles, and a stopper to close the basin so that it may be used for dishwashing. A mixing faucet to give water of the desired temperature is an advantage. This faucet is usually high enough to allow for convenient and easy filling of kettles and is on a swivel, so that it may be swung to one side out of the way. All faucets should be of a non-tarnishing metal.

A sink built into a surface should have a flat rim or be rimless. The modern practice is to have all kitchen work surfaces the same height and to build in the sink, but there is some question as to the desirability of this procedure. For most workers the built-in sink is too low when the counter is of correct height, and, when the sink is correct, the work surface is too high. Shallow sinks partially solve the problem. A narrow rim decreases the angle at which the arms must be held. When the sink is already installed and is too low, the pan may be raised on a wooden slat, or, if the sink itself is used for dishwashing, the worker may sit. Built-in sinks are frequently divided into two compartments. Dishes are easily rinsed in the second compartment with the flexible spray attachment usually provided.

Sinks vary in width from the 20-inch single compartment built into the work counter to the 66-inch double compartment with two drainboards. The single basin sink with two drainboards may be 54 or 60 inches wide; the single basin with one drainboard is usually 42 inches in width. A combination sink and stationary tub with interchangeable drainboard measures 48 inches. Sinks are 24 inches in depth from front to back, and the basin is from 4 to 7 inches deep.

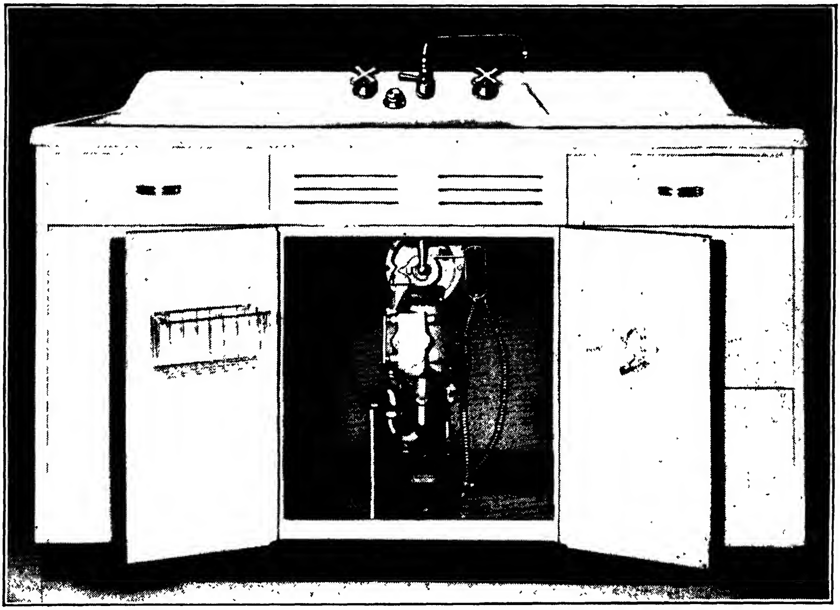
A porcelain-enameled sink is cleaned most satisfactorily with hot soapy water and a brush. Abrasives injure the surface. Scarring and roughening of the enamel may be decreased by setting heavy kettles and pans on a rubber mat. Monel metal is not scratched and is not damaged by abrasives; in fact, the appearance is apparently improved by scouring.

The sink should never be placed in the corner of the kitchen. Belonging to more than one work center, as it does, it should occupy a central position easy of access from all parts of the room.

Disposal unit

A disposal unit which eliminates the garbage pail may be installed beneath the sink. It shreds food wastes into a pulp which is flushed down the drain. (Fig. 195.) Everything but glass, bottle caps, tin cans, bulky paper, and large fruit pits may be disposed of in this way.

The unit is directly attached to a 5-inch sink drain opening which is closed by a perforated plate. A handle on this plate is turned to an "on" position for operation. Beneath the plate is a waste-receiving compartment with shredder knives, which is connected to the drain. The unit usually works more effectively if the drain connection is made vertically through the floor rather than horizontally



Crane Co.

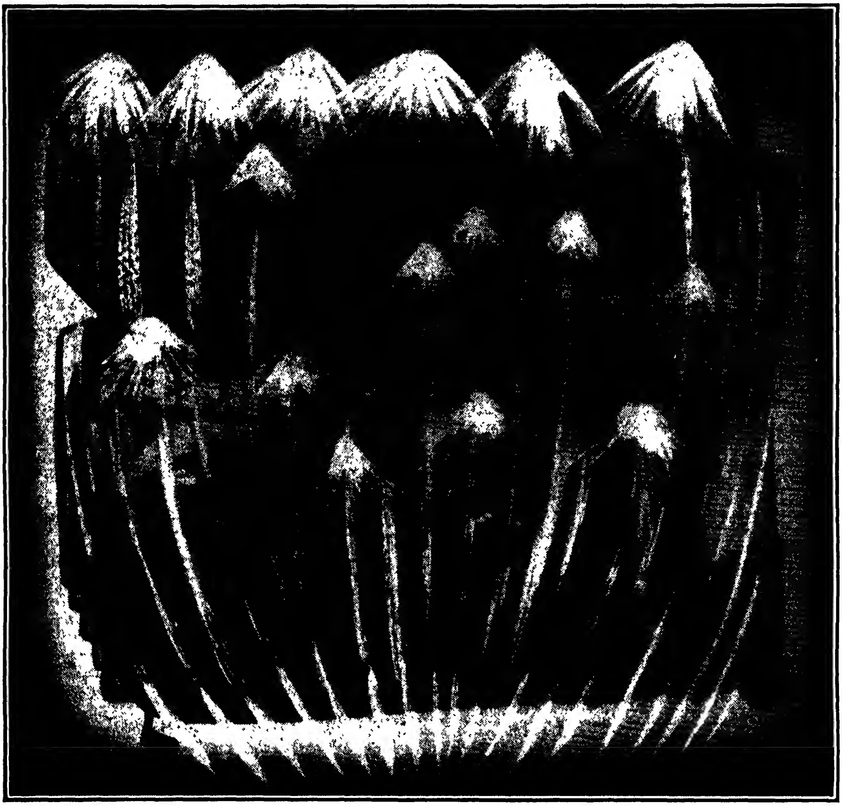
FIG. 195. A two-drainboard porcelain enamel sink with a "Disposal" unit for food wastes.

through the wall. A water-actuated switch in the cold-water supply pipe prevents operation unless water is flowing through at the correct rate (approximately 1 quart in 8 seconds). Cold water hardens any grease so that it may be chopped up by the knives and flushed away. Warm water would carry melted grease into the lower waste pipes where it might harden and perhaps cause a stoppage. The latest models are of 3-quart capacity, sufficient to take care of the normal food waste in the home.

DISHWASHER

The electric dishwasher is a recognized addition to desirable kitchen equipment. It may be a movable appliance or may be installed permanently beside the sink. "A time and cost evaluation

study of dishwashing with different equipment showed that the electric machine saved 18.32 minutes per day, or 9.16 hours per month, of the time used in the hand washing method for a family of five."[1] Sater found that the machine required no more care than the dishpan,



General Electric

FIG. 196. Inside view of dishwasher, showing water action.

and the china and glassware were more bright and glistening than when towel-dried.

Most dishwashers are electrically operated. One or two wire racks are designed to hold the china and glassware with a special basket for the silver. Both side-opening and top-opening types are available. (Fig. 196.) In the side-opening type, the racks slide in and out on ball bearings. In either type the top rack is lifted off while the lower

[1] Enid Sater, *Time and Cost Evaluation of Dishwashing by Different Methods*, p. 5.

rack is loaded. A propeller sprays the wash and rinse water over the dishes. The dishwasher uses from 4 to 7 gallons of hot water per load, depending upon the make. One model has a tubular heating unit installed in the bottom of the washer, which is turned on after the load is washed and heats the circulating air to dry the dishes. In other types the top is lifted automatically after the final scalding rinse and the dishes dry rapidly in the air.

A non-electric dishwasher is also on the market. It is jet-propelled and is operated on the line pressure of the city water main. When the lid is raised with the lift-valve open, a hydraulic lift centered in the bottom raises the basket out of the tub for ease in loading. After the dishes are in place this valve is closed, the basket lowers, and the wash valve is opened. The pressure in the hot-water pipes operates an arrangement of seven needle-spray jets at the bottom of the tub that scour the surfaces of the dishes and also rotate the basket for complete contact with the water. At the end of the wash, the lid is opened and the hydraulic lift again raises the basket while it continues to spin by momentum so that the load is air-dried. A special wire rack is provided for the spraying of vegetables.

Soap is not used in mechanical dishwashers; but certain synthetic detergents that do not form precipitates in hard water are used. Dishwasher manufacturers usually recommend the kind to use in their own appliances and specify the correct amount. Too much may be as undesirable as too little, making rinsing difficult and tending to clog the machine. Water of 160° F. is desirable, but even this temperature may not always be sufficient to reduce toxic bacteria significantly. Dishwashers, however, largely eliminate dish towels and dishcloths, make possible hotter water than the homemaker can use in hand washing of dishes, and greatly reduce the time and effort otherwise required by an ever-recurring household task.

Eating area in kitchen

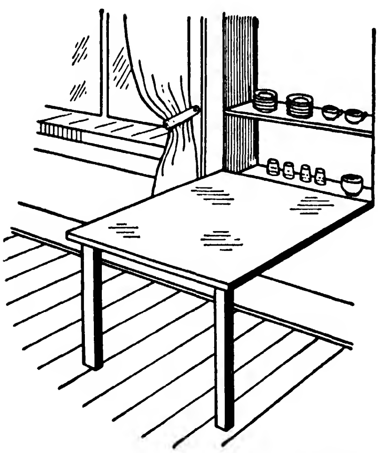
The majority of homemakers seem to desire some kind of eating area in the kitchen. In order that the routing may be the same as for service into the dining room, this area should be fairly close to the dining-room door. (Figs. 174 to 176.) The area should, however, be separate from the work area. The dining alcove with movable chairs and table has more of the atmosphere of a dining room but requires more space than when the furniture is built in. (Fig. 197.)

An area 7½ feet square is recommended for the separate unit. When tables and benches are a part of the permanent construction,

Lenore Sater Thye, BHNHE, U.S.D.A.

FIG. 197. The movable table and chairs provide flexibility in accommodating a varying number of people.

a space 6 feet square is usually sufficient. Seats should be from 15 to 17 inches deep. The table will overlap the seats approximately 3 inches. A breakfast bar should be 18 inches deep. It may be used with stools or chairs. Sometimes the simple arrangement shown in Fig. 198 may prove adequate.



Kitchen Reporter

FIG. 198. The front panel of a shallow wall cabinet may serve as eating space for one or two persons.

LOCATION

Little choice in the exposure of the kitchen is usually permitted the homemaker, but, when it is possible, the exposure chosen should depend upon the general latitude of the home, the direction of the prevailing winds, and the time of day for the preparation of dinner. In climates where the warm months are four or five in number and the heat is often intense, the kitchen should

have one exposure toward the north. North light, being reflected light, is especially desirable. When dinner is eaten at noon the northwest corner is probably preferable for the kitchen; when dinner is at night, the northeast corner is better, unless prevailing winds make another location more desirable.

Summary

Certain general principles brought out in this study will apply to any kitchen. These principles may be summarized as follows:

1. Keep the kitchen free for activities centering around meal preparation.
2. Have few doors, and group the doors near together to avoid cutting into wall space. This arrangement prevents cross traffic.
3. Group large equipment in three work centers. Equip each work center with needed small utensils.
4. Arrange the equipment so that the worker moves from right to left (unless left-handed), or continuously in one direction. This arrangement saves steps and, therefore, time.
5. Place the equipment as closely together as possible to give a continuous work surface.
6. Place the sink where it is accessible from all parts of the room. Avoid corner sinks.
7. Provide adequate storage space. Build cabinets to ceiling. Allow sufficient clearance space over work tables, and toe space at the floor. Store items at place of first use.
8. Have the work surfaces a comfortable height for the individual worker, so that large muscles may be used rather than small muscles.
9. Allow sufficient window space for adequate light and cross ventilation. Place some windows high enough to accommodate equipment beneath them.
10. Have one central, well-diffused artificial light to give general illumination and secondary lights at work centers.
11. Finish walls, woodwork, and floors with easily washed non-absorbent materials.
12. Increase safety in kitchen by having definite storage space for supplies and utensils, shelves reachable to eliminate climbing, corners rounded, non-slippery floors, adequate light.

In other words, apply some of Miss Bane's ideals for the home to the kitchen. Make the kitchen "mechanically convenient, physically healthful, mentally stimulating, artistically satisfying, and economically sound."

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13

Home Lighting

MERE LIGHTING of the home is not enough. Comfortable seeing is what counts. To our prehistoric ancestors, any light, however inadequate, that kept back the boundaries of darkness and offered even partial protection from the terrifying dangers lurking in the shadows, was welcome. Today light must do more than protect. Probably no other convenience which is brought into the home exerts so great an influence on family life as artificial illumination. Desirable illumination implies equable light of adequate wattage, so placed and shaded that it is sufficient for carrying on any occupation after dark, without strain upon eyes or nerves. It means giving the house a cheerful atmosphere where family and friends may find welcome and rest. Soft light is often pleasing but may be insufficient for tasks requiring close attention.

HISTORY

Until the last century the improvement in artificial light was so slow as to be scarcely noticeable. It is not possible to know the origin of the first fire; lightning may have set a forest in a blaze, or a spark been accidentally struck from two rocks or two dry sticks rubbed together. According to legend, Prometheus stole a coal from the Olympic gods and in consequence suffered a lamentable punishment. Undoubtedly fire was obtained in different ways in different lands. Regardless of how it was discovered, it proved a boon to the early inhabitants of the earth, a source of warmth, of protection, and of light. Roy Chapman Andrews and his party found the remains of an ancient fireplace in the Valley of the Flaming Cliffs in the Gobi Desert. Here men had built their fires twenty thousand, perhaps even a hundred thousand, years ago.

One night someone pulled a burning stick from the fire and used it to light the way to a dark corner of the cave, and man had his first torch. Or perhaps fat from a roasting animal dripped into a hollow of the rock at the edge of the fire, a dry piece of moss or a bit of rag acted as a wick, and the possibility of a saucer lamp was suggested. Lamps of this type were at first of stone or clay and crude in workmanship, but in the Greek and Roman eras the saucer lamps

used by wealthy families were made of metal and often beautifully decorated with carvings of animals and flowers.

Before street lighting was common, people who ventured from their homes after nightfall were accompanied by a link-boy with his rush torch. The use of torches, fagots saturated with fat, and of grease lamps has persisted to the present time in some parts of the world. Primitive people in Alaska burn fish stuck on a stick.

Candles were first used extensively in the twelfth century, though they must have been known before that time for there are occasional references to them in earlier literature. The use continued for hundreds of years and even today candle-lighted dining tables have a charm all their own, but present-day man would regret having to depend upon them entirely for artificial light.

About 1775, Argand, a French chemist, invented a burner with a central air draft, which gave a round hollow flame. This lamp burned animal or vegetable oil. Not until after the discovery of oil in Pennsylvania in the middle of the nineteenth century was kerosene commonly used. Gas was used in England somewhat before 1800 and in America shortly afterwards, at first for street lighting and later in private homes. Light from the fish-tail burner was not very bright and tended to be flickering even when the flame was protected from drafts with a glass shade, but, with the invention of the Welsbach mantle in 1885, steady light of sufficient brilliance was at last obtained. The Welsbach mantle is made by soaking cotton in salts of thorium and cerium and burning off the cotton, leaving a fabric of metallic oxide.

Before that time, however, men of science had been experimenting with electricity. Various electric lamps had been made but had proved impractical. The first successful lamp was demonstrated by Thomas Edison in 1879, followed, in 1882, by the first central station for generating electricity for incandescent lighting. For the first time in the long history of illumination a flame was not the source of the light. Since that time both the lamps and the generation and distribution of electricity have been greatly improved. The carbon lamp was followed in 1905 by a metallized carbon lamp, this so-called gem lamp by a tantalum lamp, and it in turn was soon succeeded by the present tungsten filament lamp.

Physics of light

Even in very early times the thoughful observer must have noted that light traveled in straight lines, since it was not possible to see

around a corner, but it was not known that light had velocity. Galileo made the first attempt to determine whether or not it had velocity and was unsuccessful, so that until 1676 light was thought to be instantaneous. In that year Römer, a Danish astronomer, studying the eclipses of the moons of Jupiter, found unexpected variations in the time eclipses occurred, depending upon the position of the earth in its orbit. Römer suggested that these discrepencies might be due to the fact that light had velocity and, by determining the differences in time when the eclipses took place, calculated the velocity as 186,000 miles per second. Later methods employed stationary and rotating mirrors to reflect light between two spots on the earth's surface. Using these types of mirrors on two mountain tops in California, Michelson, in 1924, found the velocity of light to be 186,300 miles per second.

The sense impression formed by the eye, which is known as light, does not come as a rule from a self-luminous body; the eye sees almost entirely by means of light reflected from the body. Light itself is invisible; it is the agent through which objects are perceived, a form of radiant energy capable of producing sight. There are two theories as to the manner in which it is transmitted. The corpuscular theory, the first one suggested, assumed that the lighted body shot off particles at high speed and in straight lines. This theory fitted in with many of the laws of reflection and refraction, but required that light travel faster in water than in air, which Foucault proved to be contrary to fact. The corpuscular theory also failed to explain diffraction, polarization, interference, and the apparently constant speed of light.

The other theory for the propagation of light is known as the wave theory. Faraday, Maxwell, and Hertz, each building on the work of his predecessor, developed a theory of electromagnetic waves transmitted through space. These waves were refracted and reflected in the same manner as light waves, and it was concluded that light waves were probably a form of electric waves. Light waves show a transverse motion, the waves traveling in a direction perpendicular to the path of the light. This theory of light propagation presupposes a medium. Like an ocean wave, the light wave has a series of crests and troughs, which travel forward, but the medium itself is not carried along. After the discovery of electrons it was suggested that light waves were formed by electrons oscillating in the source of the light.

The modern theory of relativity and the quantum theory advanced to explain some of the phenomena of radiation and absorption are best

explained by a modified corpuscular theory, i.e., corpuscles moving wave fashion. Apparently neither method of light propagation has been found as yet to agree with all the known facts.

Terminology of light measurement

Just as a unit is necessary in measuring volume or distance, so a unit is essential for the measurement of light. The oldest standard light unit was a sperm candle of specified size and rate of burning. The illumination given by a horizontal beam from the standard candle was known as candle power. The light from any candle flame, 1 inch in diameter, is equivalent to approximately 1 candle power. The present light standards are a set of incandescent lamps of known candle power kept by the National Bureau of Standards in Washington. France and England have accepted the same standards so that the fundamental unit is named the "international candle."

Foot-candle. It is a basic law of light that the intensity of illumination on any surface varies inversely as the square of the distance from the source of the light, the surface being at right angles to the beam. This law is strictly true only when the source is so small that it approaches a point in size. The relationship may be expressed in an equation

$$\text{Intensity of illumination} = \frac{\text{Candle power of lamp}}{\text{Square of distance from lamp}} = \frac{\text{cp}}{d^2}$$

Since in the equation $\text{cp} = \text{ft-c} \times d^2$, intensity of illumination is measured in foot-candles. The illumination on any surface or the distribution of light around a source may be determined by a photometer. The foot-candle meter is a portable photometer. By means of one or two "photronic," light-sensitive cells, which are independent of the personal error of the investigator, light energy from any direction is converted directly into electrical energy. The current, generated by the radiant energy, operates the ammeter instantaneously as indicated on the scale, which is calibrated in foot-candles in terms of tungsten filament standard lamps. The sensitivity of the cell must be equivalent to that of the eyes if it is to evaluate the intensity of illumination in accord with terms of luminous sensation.

A small foot-candle meter, adapted to home use, has a cell, ammeter, and scale, calibrated from 0 to 50 or 75 foot-candles. Captions above the scale indicate what part of the range is suitable for various tasks. A perforated disk may be placed over the cell for reading

illumination values beyond the scale, the foot-candles read being multiplied by 10. (Fig. 199.)

Lumen. Light flux or flow, the quantity which may be used, is measured in lumens. If light from a standard candle falls upon a screen 1 square foot in area, every point of which is 1 foot distant from the candle, the screen is said to receive a lumen of light. Incandescent lamps commonly used in the home give from 10 to 20

General Electric

FIG. 199. Foot-candle meter.

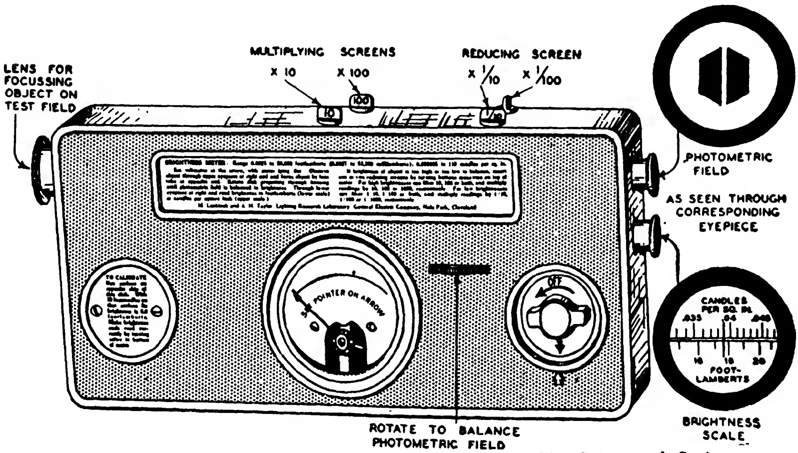
lumens for each watt of energy consumed, and fluorescent lamps, 60 lumens or more. A photometer is used to measure the lumen output, in establishing the rating of any lamp.

Lambert. The lambert is the unit of brightness. Brightness of the light source or of a reflecting surface within the line of vision and the contrast between the brightness of general and local illumination have a very important bearing on visual acuity and eye strain. Brightness should, therefore, be determined. A lambert is the uniform or average brightness of a perfectly diffusing surface, emitting or reflecting light at the rate of 1 lumen per square centimeter. The foot-lambert, used more commonly, is the average brightness of a surface when the rate of emission or reflection is 1 lumen per square foot. Foot-lamberts may also be calculated by multiplying the illumination

in foot-candles by the reflection factor for the given surface. Foot-lamberts = candles per square inch $\times$ 452 (144π).

Luckiesh and Taylor have invented a meter that measures brightnesses between 0.002 and 50,000 foot-lamberts. (Fig. 200.)

The meter has two eyepieces at the right-hand end. Through the upper eyepiece the observer views the magnified photometric field, consisting of two small silvered trapezoids separated by a narrow clear strip, as shown in the sketch on the photograph. By means of



The Science of Seeing, p. 323

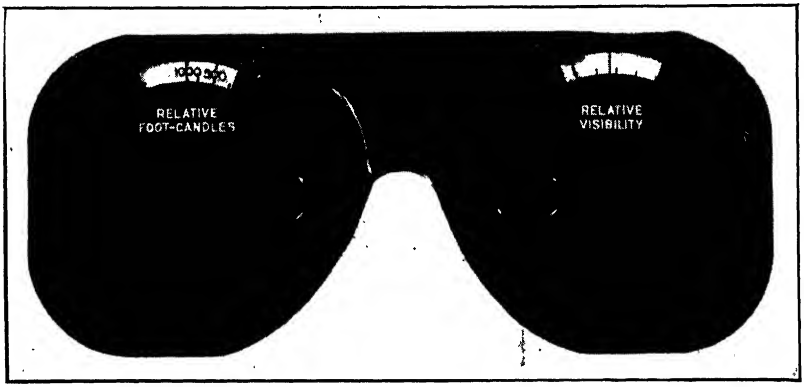
FIG. 200. Luckiesh-Taylor brightness meter.

the lens tube at the opposite end of the meter an image of the object to be measured is brought into focus in the plane of the photometric field, in the clear portion between and surrounding the two silvered trapezoids. The latter reflect the image of a diffusing glass in front of the comparison lamp, and the brightness of this glass is varied by means of a circular gradient filter. Various filters of constant transmission factor may also be inserted for extending the range of the instrument. After a photometric balance is obtained, the brightness of the test object is read from an illuminated scale seen through the lower eyepiece at the right-hand end. The values are given both in candles per square inch and in foot-lamberts.

The optical system is such that the brightness of an object approximately one foot wide can readily be measured at a distance of about 500 feet.[1]

[1] Matthew Luckiesh and Frank K. Moss, *The Science of Seeing*; D. Van Nostrand Company, 1937, pp. 322–323.

Visibility meter. Determination of the visibility of an object under different levels of illumination is an aid in securing the optimum amount. The visibility meter, a Luckiesh-Moss design, Fig. 201, "consists essentially of two colorless photographic filters with precise circular gradients in density, which may be rotated simultaneously in front of the eyes while looking at an object or while performing a visual task. The observer holds the instrument in approximately the same position that eyeglasses are worn and with a finger of the right



The Science of Seeing, p. 168

FIG. 201. Luckiesh-Moss visibility meter.

hand slowly turns a disk which rotates the circular gradients until the visual threshold or limit in the performance of the visual task is reached."[1] Relative visibility measurements are made easily and rapidly. A sufficient number should be taken on any given subject to reduce the personal error to the minimum.

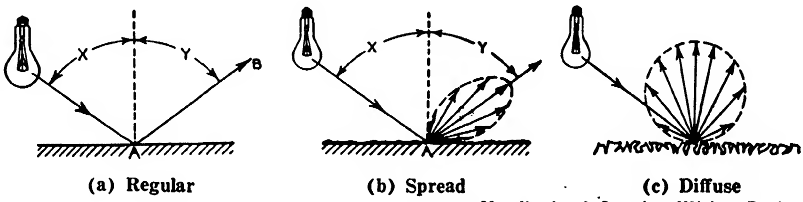
Relationship among light terms. It is customary to express light terms by letter symbols. Equations may then be written to show the relationship among the different terms. I is the symbol for candlepower; E, for illumination in foot-candles; F, for lumens; and B, for brightness. $I = Ed^2$, $F = 4\pi I$, $E = F \div$ Area (in square feet), $B = E \times$ Reflection factor. The reflection factor for any surface is obtained by dividing the foot-candle reading of reflected light from the surface by the foot-candle reading for the incident light on the same surface. To avoid error in results, the surface for which the reflection factor is to be determined should be at least 12 inches square. The foot-candle meter may also be used to determine the transmission

[1] *Ibid.*, p. 168.

factor of any translucent material by dividing the foot-candles of light transmitted through the material by the foot-candles of incident light. The brightness *B* of the translucent material may be obtained by multiplying the foot-candle reading of transmitted light, when the cell of the foot-candle meter is held against the translucent material, by a constant 1.25. The constant 1.25 is used because the light, which is incident on the cell almost equally from all angles, is diffused by the material.

Reflection and transmission of light

Light falling on a surface may be partly absorbed, partly reflected, and in part transmitted. Depending upon the nature of the surface,



Handbook of Interior Wiring Design

Fig. 202. The reflection of a beam of light.

reflection may be one of three different types: regular reflection, where the rays are thrown back along a path identical to that of the incident rays; spread reflection, when there is a scattering of the rays, but the extent of scattering is limited to a more or less definitely defined area; and diffuse reflection, where there is no limit to the scattering. (Fig. 202.) Daylight undergoes diffuse reflection from sky and landscape; artificial light, from mat-finished ceilings and walls.

In Table 1 types of reflection from different materials are shown.

TABLE 1

Light-Reflecting Materials *

Regular	*Spread*	*Diffuse*
Mirrored glass	Porcelain enamel	Parchment shades
Polished chromium	Cased glass	Flat paint
Polished aluminum	Dull aluminum	Plastics

* *Handbook of Interior Wiring Design*, p. 36.

As has been already noted, the eye sees a body by means of the light which it reflects. When light is transmitted it passes through

a material which may be either transparent or translucent. Transparent materials transmit a sufficient number of unscattered rays of light so that bodies on the other side of the material may be distinctly seen. Translucent materials are only partly transparent; they transmit rays of light but the rays are diffused, so that objects may not be seen through the material. Opaque materials do not even transmit the rays of light. Transmitted light, like reflected light, may be diffused, if the rays are scattered in passing through an opalescent or irregular surface. Hall globes and porch lanterns often have such a surface.

In the reflection and transmission of light it is important to know the distribution of that light in the horizontal and vertical planes. The distribution may be measured by a special type of photometer and the results plotted in a curve indicating the candle power in the various directions, the form of the curve depending upon the type of unit used. (Fig. 212.)

Glare

When light is transmitted or reflected in such a way that an unpleasant sensation affects the eye, fatigue is increased and attention distracted, the cause is usually glare. Glare is light wrongly directed. Direct glare comes from unshaded or insufficiently shaded lamps shining directly in the line of vision, reflected glare from a bright light falling on a polished or glossy surface from which it is reflected into the eye. Very shiny paper in a book or magazine may cause reflected glare. Spotty light gives another kind of glare, glare by contrast. This happens when one or two direct-type floor or table lamps make bright spots of illumination in a room and the rest of the room is in comparative darkness. The eye must constantly readjust itself to the brightness and the darkness, and fatigue results. Foot-candles of general illumination should not be less than one-tenth of those supplied by local fixtures.

Daylight in the home

Except in very gloomy weather, the home depends upon light from outside during the daytime. How adequate this light is would seem to be determined by the number of windows. Glass, however, may absorb or reflect as much as 35 per cent of the light that falls upon it. The thickness of the glass does not seem to have much effect, but the smoothness does, a rough surface absorbing radiant energy more readily than a smooth. According to Higbie and Bull, if frosted glass

is used in the window, as much as 7 per cent more light comes into the room when the smoother side of the glass is toward the light source. From 15 to 20 per cent of the total light may be absorbed by dirt on the glass, and in very smoky localities this may amount to as high as 25 or even 50 per cent—sufficient argument for keeping the windows clean. Glass has, nevertheless, an important part to play in diffusing the light, and, although it reduces the available light, it is not an advantage to have the windows open, for the glass distributes the light and so gives more illumination at the farther side of the room than would be obtained if no glass were there.

Other conditions, such as the use of shades and draperies, also greatly influence the amount of daylight that is available in a room. Randall and Martin have studied these conditions and report the following rather startling facts. Drawing the roller shade so that the upper half of the window is covered, cuts off 60 per cent of the daylight, but only 14 per cent is lost when the shade is restricted to the upper fifth. This great variation is due to the difference in the light transmitted by the upper and lower halves of the window. Except in congested districts of a city, the light coming through the upper half is largely reflected from the sky. By contrast, the light transmitted through the lower panes is reflected from the ground, other buildings, and shrubbery, all of which are so much darker than the sky that they may absorb more light than they reflect. Opaque shades may cut off 98 per cent of the light, whereas translucent shades usually transmit as much as 17.6 per cent. A fly screen covering the whole window reduces the available daylight 50 per cent, but not more than 15 per cent when the screen is only over the lower half. Painting the screens diminishes the light further, 9 per cent on an entire screen, 3 per cent on a half; and when the painting is repeated year after year to prevent rusting, the transmitted light is reduced to a still greater extent. For these reasons bronze or copper screens which do not require painting are preferable.

Windows are regarded as one of the most satisfactory means of decorating a room. Curtains and draperies, however, may cut off as much as 75 per cent of the light. Removing the valance may double the available daylight at the farther side of the room. Moreover, many heavy draperies and curtains increase the shadows and tend to produce a spotty condition which may result in glare, whereas a clean window and very thin curtain materials diffuse the light and soften the shadows. If draperies are desired for purposes of decoration, the

windows must be more numerous and larger to make up for the loss in light. A window area equivalent to one-fourth of the floor area is desirable. The use of glass blocks for wall construction has improved daytime lighting of the home.

In the solar house, the exterior walls on southern exposures are almost entirely of glass. (Fig. 203.) This large number of windows increases the daylight illumination of a room to a high level. Since

Libby-Owens-Ford Glass Co.

FIG. 203. These generous-sized windows greatly increase the daylight in the living room. (Architect, David S. Barrow, Hedrich-Blessing Studio.)

excessive contrasts between bright and dark areas of the room are consequently eliminated, glare is avoided and ease of seeing greatly improved.

Further experiments proved that the illumination on a vertical plane parallel to a window was twice that on a horizontal plane at the same place. A simple trial will convince anyone of the truth of this statement and show the need for holding the book or magazine at the proper angle when reading, instead of allowing it to lie on a table.

ARTIFICIAL LIGHT

Although the activities of primitive man were largely limited to the daytime, modern man, with the aid of artificial light, may continue

his work or his recreation long after nightfall. In many homes artificial light is used for more than half of the time the family is together. Various fuels are sources of illumination, but there is probably no person who does not prefer electric lights, if the location of the home makes them possible. Electric lights are safer, more easily cared for, and give illumination instantaneously. The electric light is the first and only light not dependent upon a flame for its origin. The first use, and for some time the exclusive use, of electricity was for lighting.

The development of the electrical industry is of such recent date, however, that at the present time the electric wiring in many homes is below standard. A survey in 1926 of 12,000,000 homes showed that these homes were only about half adequately lighted and had only about one-third of the needed convenience outlets.

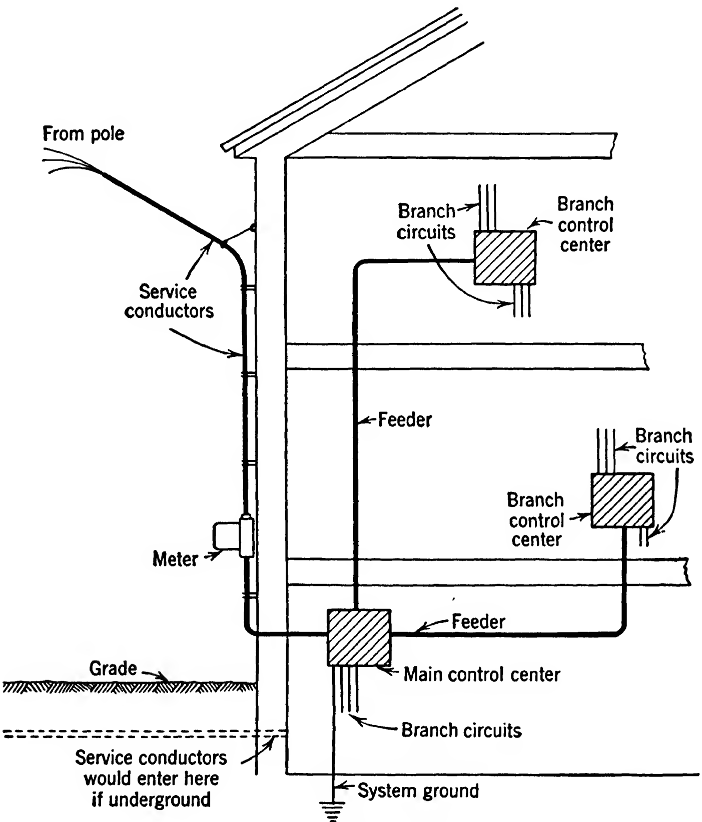
Adequate wiring. An adequate wiring system should provide comfortable lighting, conveniently controlled, with a sufficient number of well-placed outlets to allow for the satisfactory connection of portable fixtures and appliances, and individual circuits for larger stationary equipment. The circuit wires, the outlets, and the switches are the fundamental elements of any house wiring.

The number and size of the wires that carry the electricity from the power line to the house determine the present and future capacity of the wiring system. The original installation is, therefore, important. The type and quality of the wiring installation are regulated by the Electric Code of the National Board of Fire Underwriters (p. 57). This code specifies the size of wire to be used in the different circuits and the size of fuse needed for protection. The Electric Code is, however, a standard of safety, not a measure of adequacy. Requirements for safety must be met, but an efficient electrical system must also serve the needs of the household effectively.

The service circuit should be a three-wire, 70-ampere system, the wires not smaller than No. 6; if the house contains more than 1500 square feet of floor area, larger wires of 90- or 100-ampere capacity are recommended. (Fig. 204.) The point of connection of the electric supply line, known as the service drop, should not be less than 10 feet above sidewalks and 18 feet above alleys, public roads, and driveways.

After a three-wire service entrance of sufficient size has been specified, the next step is to determine the number of branch circuits to be installed in the house and the size of wire for each. Circuits are usu-

ally divided into three types: general purpose, appliance, and individual equipment. (Fig. 205.) The general-purpose circuits, protected with a 15-ampere fuse or circuit breaker, serve all lighting outlets and convenience outlets in living rooms, bedrooms, and bath-



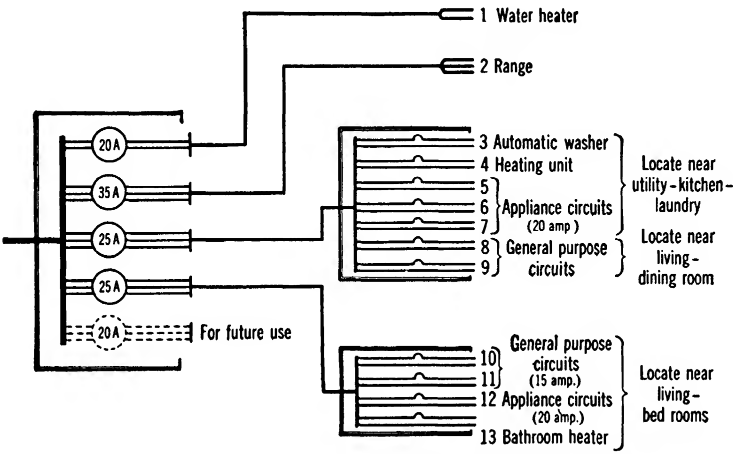
"Home Wiring Handbook," Westinghouse

FIG. 204. Schematic drawing of service conductors and radial wiring system.

rooms, and in other areas not served by the appliance circuits. No fixed appliance of more than 6 amperes and no single portable appliance with a rating of more than 10 amperes should be used on the general-purpose circuit, but stationary clocks and the small ventilating fans commonly used in kitchen and laundry should be connected into one of these circuits. Although this circuit may have a conductor of No. 14 wire, No. 12 wire is recommended. Circuits longer than 35

feet should always be of No. 12 wire. At least one general-purpose circuit should be provided for each 500 square feet of floor area.

It is usually preferable to have two circuits in each room, with some of the lights and convenience outlets on one and some on the second. This does not mean twice as many circuits as there are rooms in the house, for both circuits may run through several rooms. Such an arrangement distributes the load more evenly, lessens voltage drop, and prevents all the lights from going out when a fuse is blown.



"Home Wiring Handbook," Westinghouse

FIG. 205. Feeders and circuits for a well-wired home.

The appliance circuit has as the minimum a No. 12 wire conductor protected by a 20-ampere fuse or circuit breaker. A No. 10 conductor fused with a 25-ampere circuit breaker will provide greater flexibility, with less danger of overloading, and should be installed for runs exceeding 45 feet. These circuits serve appliance outlets in the kitchen, breakfast room, and dining room, and in laundry, utility room, and garage. A sufficient number of appliance circuits should be installed to care adequately for all needs. When lights dim and appliances heat slowly, usually the trouble is not with the equipment but with inadequate circuits of too small wire. Appliances of more than 15 amperes should not be attached to an appliance circuit but should have their own individual circuits.

Current for nearly half of the general-purpose and appliance circuits in present-day use are supplied at 115 volts or less. An effort is being made, however, to bring all circuits to 120 volts, so that lamps

and appliances may be made for the same voltage and the possible use of incorrect voltage eliminated.

Individual equipment circuits are used to connect larger appliances such as the electric range, water heater, clothes drier, and bathroom wall heater to the house wiring system. Most of these pieces of equipment either require or are more satisfactorily served by a 115/230 or 120/240 volt circuit.

The final step in planning the house wiring system is to determine the number of control centers, their size, and their location. It was formerly the custom to locate the fuse box in the basement. Since the General Electric Company introduced the radial wiring system in 1937, however, a control center is more frequently placed near a load center. (Fig. 204.) One such load center would be in the kitchen—90 per cent of the current will be used within 10 feet of some location in the kitchen. The electric range is in the kitchen; small electrical appliances are used here or in the adjacent breakfast alcove or dining room. The laundry with its equipment is in an adjoining utility room; above, on the second floor, is the bathroom, where an electric heater may be used. Circuit breakers are especially suitable for a kitchen installation. In this arrangement fuses are not used, but protection against an overload is obtained by the unequal expansion of a sensitive bimetal strip that breaks the connection and cuts off the current. When the cause of the overload has been removed, the switch may be reset by two simple movements, similar to tripping a tumbler, so that the circuit breaker tends to reduce the length of lightless periods.

Other control centers should be placed at readily accessible locations on the several floors of the house. The main control center may be in the basement or wherever the service conductors enter. If there are not more than six feeders, controlled by fuses or circuit breakers, no main circuit breaker need be installed. (Fig. 205.) The National Electric Code requires a main breaker when the number of feeders or branch circuits is more than six. From the main center, feeders of No. 12 or No. 10 wire, not over 25 feet in length, run to each branch center. From these branch control centers, comparatively short circuits radiate to the adjacent rooms. In this system heat losses are reduced to the minimum, with increased efficiency in the operation of appliances; voltage drop is negligible; the house wiring is conveniently controlled; and operating expense is lowered. Control centers now available are more compact in size and more attractive in appearance than those marketed before the war.

Several different forms of radial wiring are possible. The one illustrated in Fig. 204 is especially adapted for economical installation in residences requiring a limited number of branch circuits. The average homemaker finds it difficult to visualize all the use that she will ultimately make of her electric service. It is a good plan, therefore, to list the light fixtures and appliances that are needed at the present and also those which she plans to add within the next 5 years and provide for them in the wiring layout. Even then at least two spare terminals should be left in the distribution control cabinet for additional circuits, which may be extended later. (Fig. 205.)

Convenience outlets

A sufficient number of convenience outlets should be provided to allow any piece of furniture to be placed anywhere in the room, without extension cords crossing doorways or other parts of the room where they will be in the way. Outlets in living room and bedrooms should be placed so that no point along the floor line of any usable wall space, 3 feet or more in length, is over 6 feet from an outlet. In the dining room points may be 10 feet from an outlet; in the kitchen one outlet should be installed above each work area and an additional outlet for the refrigerator. Or the kitchen requirements may be met by installing an outlet for every 4 feet of work-surface frontage, exclusive of sink and range. Care should be taken not to place an outlet in the center of a long wall where a large piece of furniture would be placed in front of it.

In the living room additional outlets may be located on the fireplace mantel for connecting decorative lights or a clock. If the living room is large, one or two floor outlets at convenient spots are desirable; they eliminate lengths of cord across the floor. Such a floor outlet is also desirable under the dining table, for attaching electrical appliances. If a floor outlet is not feasible, an outlet may be installed in the wall, as near the chair of the hostess as possible.

With the exceptions already noted, convenience outlets are usually placed in the wall, 10 to 16 inches above the floor line. In the kitchen and laundry, however, they are at a suitable height for connecting appliances. Ordinarily this height is 42 to 48 inches above the floor, but any height may be selected by a person building his own home. In the breakfast alcove the outlets are often on the end wall just above the table. A high outlet may be installed in the bathroom, away from the tub, for curling iron or electric razor, although it is generally considered safer to keep electrical appliances out of

this room. There is no danger unless wiring or cord is defective, but such a flaw may only be discovered too late, after a fatal accident has occurred. Special-purpose outlets are usually limited in use to some special piece of equipment such as telephone, radio, or push buttons.

Several other methods of installing convenience outlets have been introduced. Although intended primarily for installation in older houses, they have advantages which make them acceptable for new construction as well. One type, known as the plug-in strip, is made of two continuous slotted copper conductors, separately insulated and placed ½ inch apart in a metal channel. The covering, also of insulating material, has two parallel slots at 6-inch intervals, to which appliances may be attached. The strip is fastened at the back of the work surface or above the baseboard and connected to a circuit. Other systems use metal or rubber raceways, which may be cemented to the wall or fastened with upholstery tacks. They are usually connected to a convenience outlet. Receptacles are spaced at any desired distance. All types are comparatively inconspicuous, greatly augment the available outlets, and make possible the use of short extension cords, increasing the safety of electrical connections.

Evergreen trees on the grounds may be decorated at Christmas time and other lighting fixtures and appliances may be used for special evening festivities if there are weatherproof outlets at strategic points on the outside of the house. Such outlets should be controlled by switches on the inside of the house.

Switches

Switches should be sufficient in number and so located that it is possible to light any room as it is entered, and to leave it in darkness, without retracing steps. To do this, any room having more than one entrance should have multiple switch control. Some authorities suggest that switches at all entrances are essential only when the doorways are more than 15 feet apart; other authorities say 10 feet apart. But unless two entrances are practically adjacent, some steps must be retraced in darkness when only one switch is provided. In the lower hall two three-way switches are required, one to control the light in the lower hall and a second to control the light at the head of the stairs. On the upper floor, two similar three-way switches are used.

Wiring diagrams of single-pole and three- and four-way switches are shown in Fig. 206. The upper diagram indicates that a light may

be turned off or on at two separate locations. In the diagram a light is on, the current flowing through the wires represented by the solid lines. Either switch may now be turned so that the connection repre-

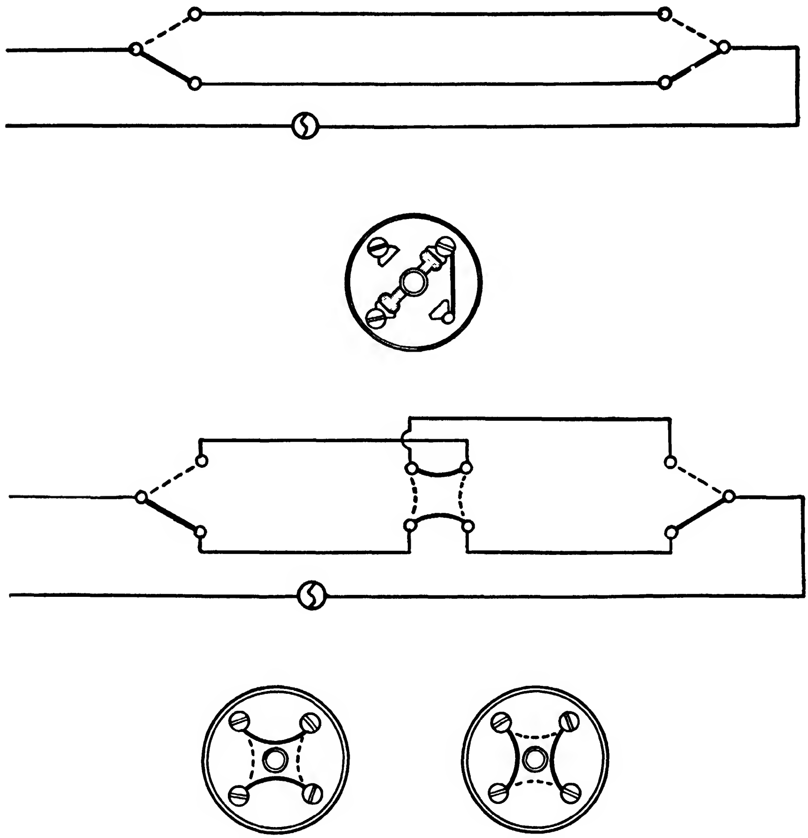


Fig. 206. Light controlled from two and three locations.

sented by a dotted line is made. The light is then off. At another time this switch may be thrown back to its original position or the other switch thrown to the position of the dotted line, when the circuit is again complete and the light on. When a light must be controlled at three locations, wiring connections shown in the lower diagram are installed. The two end switches are the three-way type, but the third switch, at the intermediate location, has four poles which are

always joined in pairs. As the diagram is drawn, the circuit is complete and a light on. If any one of the switches is thrown, it takes the position of the dotted line or lines and no current flows. Another of the switches may now be thrown to its other position, and the circuit will again be complete. Any number of four-way switches may be inserted between the two three-way, giving additional control locations in a given circuit.

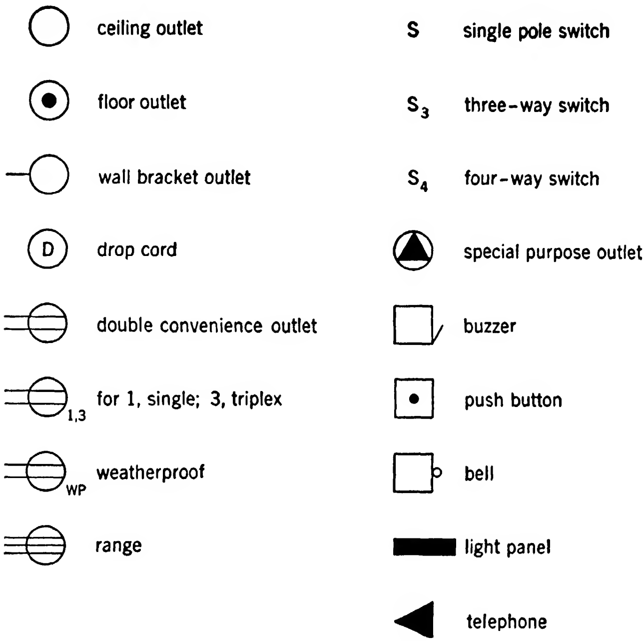
Every room should have at least one light that is controlled by a switch at the entrance. Sometimes it is convenient to have the outlet for a portable lamp so controlled. One type of duplex outlet contains two receptacles separately wired, so that one may be connected to a switch. Bracket outlets may be switched on, or turned on at each individual socket. When a central fixture contains three or more lamps it may be desirable to have only part of them lighted; a specially designed switch makes it possible to turn on one lamp at a time or several in a group. A master switch may be installed in a bedroom, by means of which all the lamps in the principal rooms may be lighted at one time as a protection against burglary. A switch on the hinge side of the door is used to turn a light in the closet on and off automatically with the opening and closing of the door.

The switch is placed 4 feet from the floor on the lock side of the door, never behind it. Switch plates may cover several switches grouped together or a switch and single or double convenience outlet. Such an outlet is especially useful for connecting the electric cleaner. Both switch plates and outlet plates may be of metal or of a non-conducting composition material which may be painted to match the wall. The location of the switch is often marked by a spot of luminous paint, and luminous balls or cylinders are attached to the end of pull chains. A new switch has a small electronic bulb built into the top of a plastic wall plate. It provides a guiding glow when lights are off. Pilot lights on outlet plates or near the door at the top of the cellar stairs indicate when a circuit is made or broken.

Because of their easy manipulation by a slight touch of hand or arm, tumbler switches have largely replaced the push button. A mercury switch which operates silently is used in some of the newer installations. It is limited in capacity to 5 amperes and must be installed in a vertical position because its operation depends upon the rotation of a button containing an orifice which allows the mercury to flow back and forth to make or break the circuit.

WIRING SYMBOLS

With some slight variation, most architects and electrical contractors use the following symbols in indicating the wiring layout for a house:



The floor plans of Figs. 207 and 208 show typical wiring layouts.

TYPES OF HOUSE WIRING

Conduits may be installed for the house circuits, but, because of the expense, metallic or non-metallic sheathed cable is more common. In BX metal-armored cable the insulated wires are protected by a steel covering, which is spirally wound to make it sufficiently flexible to bend around corners. Nails will not penetrate this covering, nor can mice or rats gnaw through it. This security from mechanical injury makes BX preferable if it is grounded. In the non-metallic cable, Romex, the separately insulated conductors are encased in an outer sheath which has been treated to make it water-, fire-, and rodentproof, eliminating the need of additional protection. (Fig. 209.) Sometimes wiring is by the knob-and-tube system in which the con-

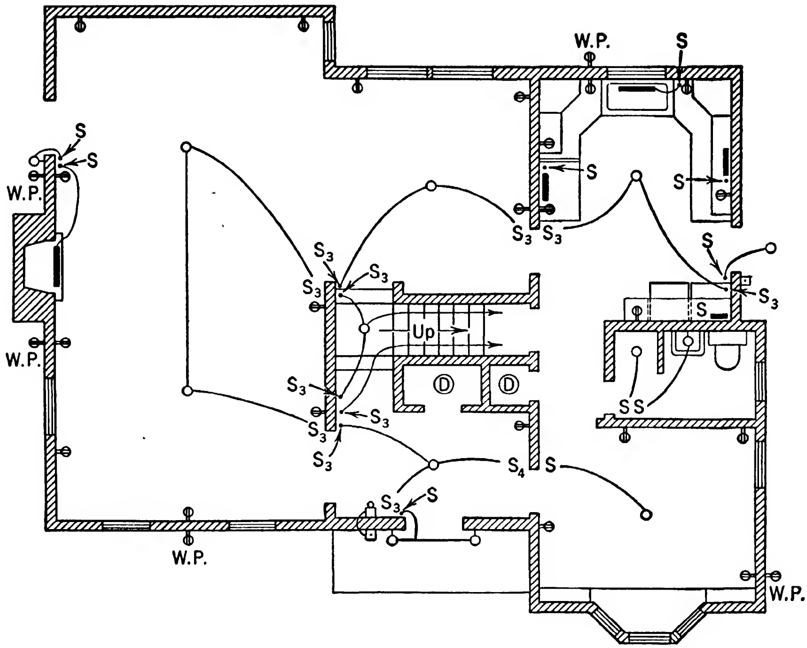


FIG. 207. Wiring layout for a house, first-floor plan.

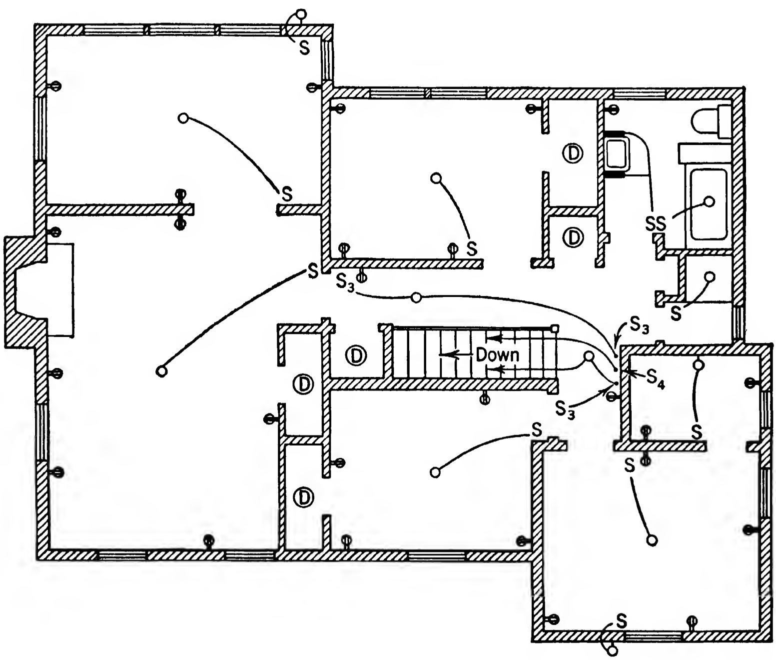
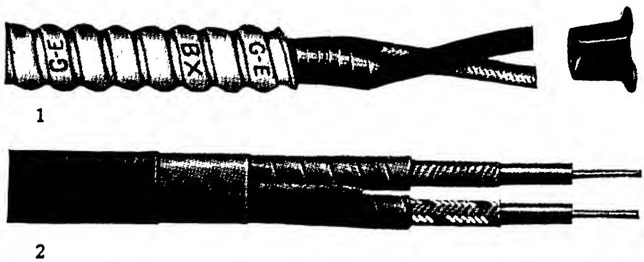


FIG. 208. Second-floor plan.

ductors are fastened at regular intervals to porcelain insulators except where they pass through the house joists, where porcelain tubes carry the wires and insulate them from contact with the wood. When the conductors are within the partitions, they must be covered with flexible tubing. In general, this method is not as safe as the other systems, but it is less expensive. If the cost of knob-and-tube wiring is considered 100 per cent, the cost of the non-metallic cable is 125, of BX 133, and of the conduit 196 per cent.

Back of the lighting fixtures and wall outlets are small metal boxes, inside which the conducting wires are connected to the sockets.



"Home Wiring Bulletin," General Electric

FIG. 209. Types of cable: (1) BX armored; (2) non-metallic sheathed.

These boxes prevent any bare wires from coming into contact with flammable materials.

FIXTURES

Light is used to give general illumination, for localized work, and for decorative purposes. In good lighting, the source and intensity of the light are adapted to its use. The well-wired house needs only attractive fixtures to be complete. Fixtures, or luminaires as they are more correctly called, to be attractive must be suitable. One type of luminaire will be used in a mansion and another type in a cottage, a different one in the drawing or living room from the one in the kitchen. The trend is toward simplicity, with the avoidance of cheap imitations. The construction and convenience of the luminaire must be considered, but it is always well to remember that adequacy of illumination for eyesight conservation is the most important point in selection. Chapter 2 in Myrtle Fahsbender's *Residential Lighting* is an excellent discussion of the relation of period style to fixture design.

It is preferable to have a central fixture, controlled by a wall switch, in each room to give general lighting, although the tendency in

recently built homes is to omit it in the living room. This outlet may not be necessary if the room is used only by the family, but social occasions often make such a light desirable. Unless there is some other source of general illumination, it is better to provide the outlet even if the fixture is not installed. It may be covered with an inconspicuous plate, and much inconvenience and expense will be saved if the fixture is installed at some future time.

Westinghouse

FIG. 210. General illumination is made possible by coves over all the windows.

William A. Kimbel, Chairman of the Advisory Board of Design of the American Lighting Equipment Association, in reporting to the president of the association, said, "Balanced illumination in a room to meet all needs is the ultimate purpose of lighting installation. Without complete balance and flexibility, no space is perfectly lighted. Overhead lighting is an essential part of such balanced illumination. Without it, neither balance nor flexibility is complete." [1]

When the ceiling outlets in living rooms, which include dining room, study, and bedrooms, are omitted, wall, valance, or cove lights of one kind or another should be used. (Fig. 210.) Wall-bracket outlets may be installed approximately 5 feet 8 inches above the floor in any room. With the exception of bathroom and kitchen they

[1] *Illum. Engg.*, 35:575, 1940.

have chiefly a decorative value, which is increased by using them in pairs and also, if possible, with a balanced effect on either side of a room. In the bathroom a bracket on each side of the mirror illuminates both sides of the face equally. Tasks at kitchen sink, stove, or preparation table are carried on more efficiently if there is added illumination at these work centers. At the present time soffit panels and lumiline and fluorescent lamps are frequently used in kitchen and bathroom instead of brackets. (Fig. 220.)

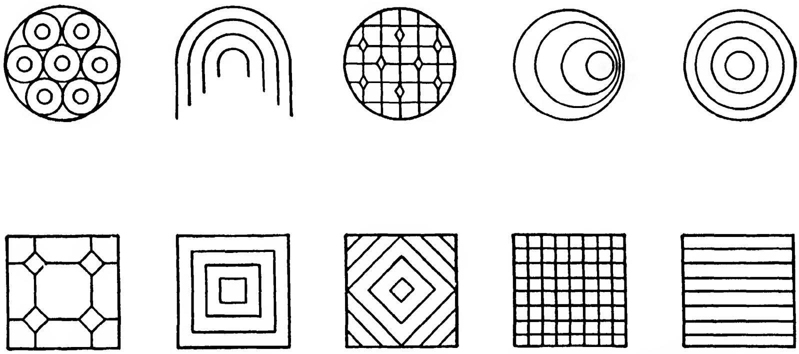


Diagram from W. E. Barrows, Light, Photometry and Illuminating Engineering, p. 301.

Fig. 211. Louver patterns.

Luminaires are classified into three types: the direct, which throws all the light downward on the surface to be illuminated; the indirect, which throws the light on ceiling and the upper part of the walls from where it is redistributed in well-diffused light throughout the room; and the semidirect, which may direct most of the light toward the ceiling but send a small part downward on a limited area or, vice versa, distribute the smaller portion over the ceiling and the larger amount downward. Some authorities recognize a fourth type, the enclosing globe of opal glass, by which the light is diffused evenly in all directions. Whatever the type, wherever the location, all lamps should be shaded. If indirect luminaires are used, the ceiling and upper walls must be light in color to reflect the light. Dark colors absorb a large portion of the light rays.

The greatest quantity of light is obtained by the direct luminaire. It concentrates the light at the desired surface and the minimum amount is lost in transmission. The quality, however, is inferior, for the space covered by the light is comparatively small and forms an objectionable contrast with the darker surroundings so that glare is produced. Lighting specialists who advocate a level of illumina-

tion higher than 40 or 50 foot-candles recognize the difficulty of obtaining it entirely with indirect or semi-indirect fixtures and suggest the use of louvered systems. Louvers are of several different kinds. (Fig. 211.) Experiments indicate that the concentric ring type, about 1½ inches deep, etched or painted a mat white or gray is preferable. It is somewhat less efficient than those with a polished

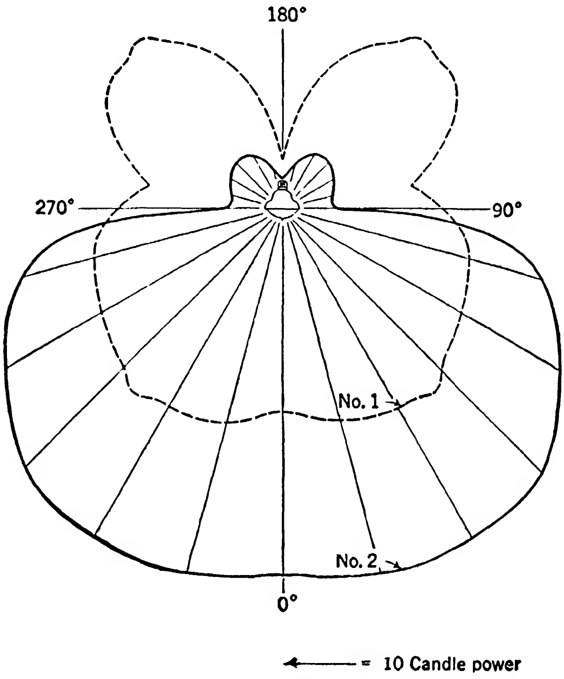


FIG. 212. Distribution of light around lamp, without and with a shade.

surface, but shiny faces tend to reflect images of the filament and produce glare.

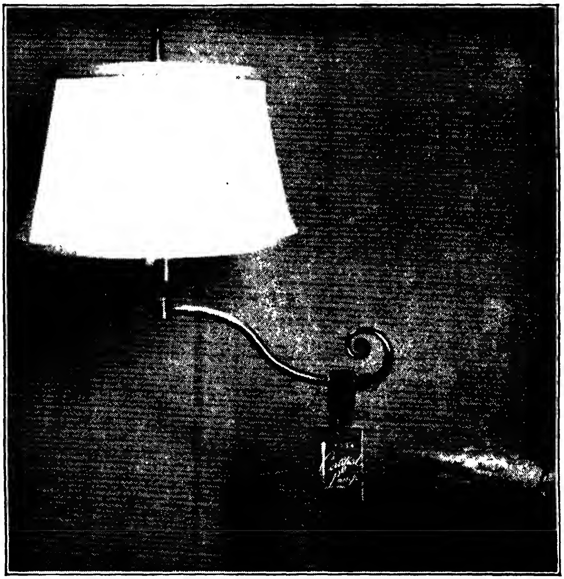
The totally indirect light loses most in transmission and absorption, on account of the length of path the rays traverse, but the light is highest in quality. The almost perfect diffusion practically eliminates shadows, unless lamps of very high power are used in an attempt to secure the 100 or more foot-candles of illumination recommended by certain investigators. Under such conditions a comparatively small ceiling becomes itself a direct source and causes glare. The semi-indirect fixtures share the advantages and disadvantages of the other two types according to the proportion of light

which is directed to ceiling or floor. Since the type of fixture largely determines the amount of illumination obtainable from any source, it is important to know the distribution of light under various conditions. Curves in Fig. 212 illustrate the distribution of light without a shade and after a shade has been placed over the lamp.

Fixtures may be chosen not only for the quality and quantity of light they distribute, but also for their beauty. Their design and color should harmonize with the furnishings of the room and the house as a whole. The level of general lighting in a room should not be less than $\frac{1}{10}$ of the local lighting at desk or easy chair, and a ratio of 1 to 5 is considered even more desirable.

Floor and table lamps

Floor and table lamps are finding extensive use in the modern home. They are obtainable in a wide variety of styles, but un-



Westinghouse

Fig. 213. All C.L.M. lamps carry the tag shown.

doubtedly the most satisfactory lamp, in respect both to supply of adequate illumination and to service, is the Certified Lamp. (Fig. 213.)

The first certified lamps were manufactured to specifications prepared by the Illuminating Engineering Society in 1934. They were

originally designed as desk or table lamps, primarily for student use, and had very definite measurements for height of standard, diameter

TABLE 2

C.L.M. Reference Table *

C.L.M. Type	Approximate Lamp Height, inches	Approximate Shade Diameter, inches	Reflector Style and Size, inches	Lamp Bulb Type and Wattage	Average Foot-Candles Supplied on Reading Surface
Reflector, table	28	16	Style B, 8	Incandescent,† 50-100-150	20
Reflector, table, combination incandescent and fluorescent	28	16	Style B, 8	Incandescent,† 50-100-150, Plus circular fluorescent, 32	35
Reflector, end table	25	16	Style C, 7½	Incandescent,† 50-100-150	20
Reflector, wall	Lamp to be mounted 55 in. from floor to top of shade	12	Style B, 8	Incandescent,† 50-100-150	20
Two sizes:			A diffusing disk is used to minimize reflected glare from glass, mirror, or highly polished wood surface		
dressing table (vanity)	20	10		Incandescent,† 30-70-100	20 On side of face
dresser	26	10		Incandescent,† 30-70-100	20
Reflector, floor	50	18	Style A, 10	Incandescent, 100-200-300	30
Reflector, floor, combination incandescent and fluorescent	59	18	Style A, 10	Incandescent, 100-200-300, Plus circular fluorescent, 32	45
Reflector, bridge	56	12	Style B, 8	Incandescent,† 50-100-150	20
Double-swing reflector, bridge	56	16	Style B, 8	Incandescent,† 50-100-150	20

* Myrtle Fahsbender, A Review and Preview of Certified Portable Lamps, *Lighting and Lamps*, June 1947, pp. 120–121.

† Medium screw lamp bulb base.

of shade, and size of diffusing bowl. The shade had a white lining. Similar construction was later available in floor and end-table lamps and in pin-up luminaires. Lamps were tested by the Electrical

Testing Laboratories, and all that met the required specifications carried an I.E.S. certification tag.

In 1943 the Illuminating Engineering Society withdrew the right to use the I.E.S. insignia on the tag. Meanwhile, a technical subcommittee of the society's Residence Lighting Committee had been working out new recommendations for residence luminaires. The recommendations specify certain features of electrical, mechanical, and lamp-shade construction, and safety requirements but do not impose conditions of design, which include finish of stand, base, and shade, and decorative treatment. These characteristics are left to the option of each manufacturer. About a hundred lamp manufacturers have organized a group, known as the "Certified Lamp Makers," and they have adopted the suggested standards and applied them to the production of certain table, floor, and wall lamps.

Westinghouse

Fig. 214. The C.L.M floor lamp has a 10-inch reflector encircled by a 12-inch 32-watt circular fluorescent tube.

Nine types of lamps are now being manufactured to the C.L.M. specifications. These types, with an outline of significant data on each lamp, are listed in Table 2.

The lamps will be tested by the Electrical Testing Laboratories for individual specifications of lighting performance and service and for visual comfort as well as for safety and mechanical and electrical construction. It is interesting to note that special emphasis is placed on shade design. Shades are tested over a 24-hour period at temperatures of 85° F. and not less than 85 per cent relative humidity. Under these conditions the shade must show no discoloration and no distortion when holding a weight of 10 pounds placed evenly on the top. The inside of the shade must reflect not less than 65 per cent of the light from an incandescent lamp placed in the center of the shade. No C.L.M. lamp supplies less than 20 foot-candles of light to the specified test plane. The development of the circular fluorescent tube has made possible the inclusion of these tubes, together with the filament lamp, in certain models. (Fig. 214.) The 12-inch, 32-watt fluorescent tube is used. (Fig. 215.) The ballast is built into the base

of the lamp, and a separate switch operates each type of light source. The switch for the fluorescent tube is turned or pushed as far as possible and held in that position until a glow appears in the tube near the contact. The switch is then released and the tube comes to

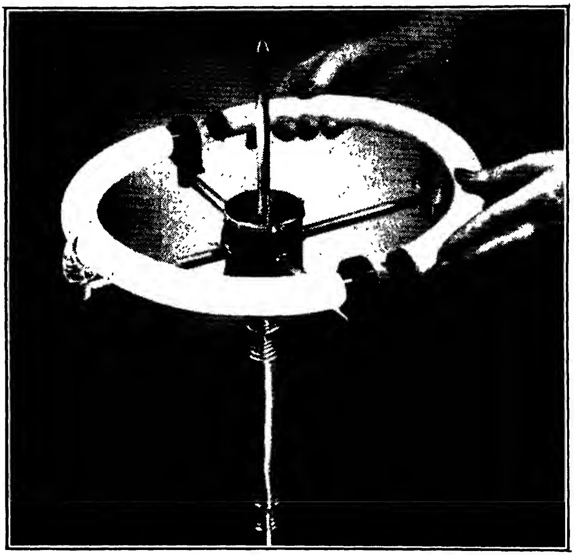


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FIG. 215. The circular fluorescent tube is also made in two semicircular parts. This type of construction increases ease of replacement. The semicircular tube may be used singly in desk lamps and in wall brackets and pin-up fixtures.

full light. A special device is installed to reduce radio interference in the circuit.

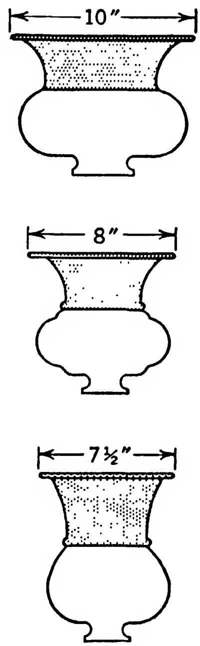
The principal difference between the new C.L.M. Lamps and those known in the past as I.E.S. Lamps, are the reflector shapes, reflector brightness and the distribution of light.

The C.L.M. reflector is composed of two pieces—a mold-blown piece of glassware and a metal top which notches securely into the glass reflector bowl. (Fig. 216.)

There are three sizes of C.L.M. reflectors: Style "A" 10 inch, Style "B" 8 inch, Style "C" 7½ inch, and each is of a different contour. I.E.S. lamps, with the exception of the end-table lamp, produced 60 per cent of the light upward and 40 per cent downward. C.L.M. lamp distribution is just the opposite—upward illumination is 40 per cent and the downward is 60 per cent. C.L.M. glassware has an average bowl brightness of approximately 5 candles per square inch as compared with a maximum of 3 candles per square inch brightness of I.E.S. reflector bowls.

C.L.M. lamps are designed to use two-filament bulbs to give a choice of lighting levels—a high or a low. In other words, the switch permits the operation of both filaments simultaneously or one filament alone (the lower wattage). For example, on the first turn of the switch a lamp using a 100/200/300 watt bulb will operate the combined 100 and 200 watt filaments or a total of 300 watts. The second turn of the switch will operate the low wattage filament alone or 100 watts.[1]

All lamps are designed for definite sizes and types of lamp bulbs, and only these should be installed.



Westinghouse

FIG. 216. C.L.M. lamps have the new reflector bowls. The bowl consists of two pieces — a mold-blown piece of glassware and a metal top notched securely into the bowl.

DIFFUSING MATERIALS

Many lamps not constructed to C.L.M. requirements use glass and plastics for surrounding globes or bowls and for adapter reflectors. They play an important part in reducing the apparent brightness by scattering the rays of light.

The glass may be any one of several different kinds. Homogeneous white opal glass has superior diffusing qualities. It is also obtainable in color. The flashed or cased opal glass is made of crystal glass with a coating of the opal. Either the clear glass or the flashing may be colored. Opalescent glass has a variegated effect, with tinges of color caused by a more or less uniform dispersion of crystalline particles through it. When a crackled, pebbled, stippled, or rippled surface is applied during the manufacturing process, the glass is a configurated type. There are numerous other varieties with different diffusing properties and uses, for example, antique, cathedral, molded, cased, and alabaster. A recent addition of interest is structural glass used in place of opaque materials for building blocks and tile.

Cellulose acetate plastics are used for lighting panels; methyl methacrylate plastics for panels and also for diffusing domes, bowls, and shades. The plastics are light in weight, an advantage in large sizes, and are frequently shatterproof and tougher and more adapta-

[1] Myrtle Fahsbender, A Review and Preview of Certified Portable Lamps, *Lighting and Lamps,* June 1947, p. 122.

ble than glass for certain applications. They transmit 85 to 95 per cent of visible light, which is comparable to the optical characteristics of glass.

The diffusing ability of certain light-transmitting materials is shown in Table 3.

TABLE 3

LIGHT-TRANSMITTING MATERIALS *

Non-Diffusing (Transparent)	*Partially Diffusing*	*Highly Diffusing*
Clear glass	Sand-blasted glass	Opal glass
Clear plastics	Etched glass	Plastics
	Silk and similar fabrics	Parchment

* *Handbook of Interior Wiring Design*, p. 37.

CORDS

Floor and table lamps require the use of cords. Lamp cords that have been tested by the Underwriters' Laboratories are furnished with an encircling yellow marker every 3 feet. Only cord so marked should be purchased. Markers on cords used with heat appliances such as irons, percolators, toasters, and electric roasters are of three different colors: blue indicates that the cord has been subjected to a 1000-cycle endurance test; red indicates a 3000-cycle test; and gold a 10,000-cycle test.

HOUSE FIXTURES

Entrance. At the entrance, lanterns or globes may be placed at either side of the door, at one side only, or above the door, to shed light on the steps and upon the faces of people at the door. (Fig. 217.) Additional lighting may be necessary when the entrance fixture does not illuminate all the steps sufficiently, a situation which may occur if there is a terrace or if the steps descend in a series of flights. In these cases concealed lights at the edge of each step or a post light at the edge of the terrace will help to eliminate shadows.

An illuminated house number is greatly appreciated by evening visitors. A standard lamp of low power or a special type that operates from a small transformer at very slight cost may be used for this purpose.

Hall fixtures. The entrance hall should be well lighted by a pendent luminaire or an enclosing globe. (Fig. 218.) A light should be provided for each 15 linear feet of hallway. If the hall is large,

bracket lamps on either side of a mirror or a table lamp may be used in place of one ceiling fixture to give supplementary light. These lower lights are attractive and add variety. The ceiling outlets in the lower and upper halls must be placed so that no shadow will fall upon the stairs. Additional outlets are recommended on landings, whenever they are necessary to light the stairs adequately. An illuminated niche on a circular staircase is pleasing and serviceable.

General Electric

Fig. 217. A well-lighted entrance.

Switches for turning on hall and stair lights should not be placed so close to the steps that a person may take a misstep and fall when reaching for the switch. A hall closet should be lighted by a fixture operated by a pull-chain or by an automatic switch in the hinge of the door.

Living room. The living room is used for so many different kinds of work and recreation that a variety of light is required. As has been said, a central fixture is desirable—two of them if the room has a floor area greater than 400 square feet or if the length is more than twice the width. Rooms with unusually low ceilings may also need a second ceiling fixture. The fixtures should harmonize with the furnishings and decorations. Portable lamps supply needed light beside easy chairs, at the piano, and at the desk. Place floor or table lamps behind and to the left of chairs to eliminate shadows. Unlined shades of portable lamps should be light in color; creams or pale

yellows give a warm glowing illumination. Dark-colored shades absorb light and give spotty effects. If a dark color is desired to fit in

General Electric

Fig. 218. Stairs should be well lighted to prevent accidents. Note the night lamp at the head of the stairs.

with the color scheme, use it in a narrow band, in tiny figures for a border, or in the lamp base. A shade should be sufficiently thick to conceal the outline of the lamp and deep enough so that the bulb is not visible, even to a person seated near by. The inside surface of the shade should be white to afford maximum reflection. The height

of the lamp standard should be suited to the chair with which it is placed.

As has been already noted, wall-bracket lights may be used to increase the general illumination, and similar results are obtained with luminous coves and lights installed behind valances and inside book cases. (Fig. 219.) Emphasis at present is directed toward raising

General Electric

FIG. 219. Cove lighting in the alcove greatly increases the level of light in the room.

the level of the over-all illumination in a room to such an extent that local lighting will no longer cause spotty areas of light against a somewhat dim background.

Bright-colored light should be used only for ornamental purposes, in shaded wall brackets, an illuminated figure on the mantel, or in a vase on a low table. Light for decoration will be discussed at greater length later.

Dining room. In the dining room the table is the central point of interest and is most attractive when flooded with a well-diffused light. The height at which the fixture is hung above the table is important. For the dome luminaire 24 inches is a good height; this

does not obstruct the view and yet is low enough to prevent the light from shining into the eyes of those seated. Shaded shower fixtures are hung 36 inches above the table. Even the candle type of fixture, which became popular during World War I because of the scarcity of glass ingredients at the time, should be shaded. A semi-indirect fixture has an indentation in the bottom for a lamp which throws direct light on the table. A spotlight recessed in the ceiling oc-

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Fig. 220. Fluorescent lamps are used in this kitchen in ceiling fixtures and below cabinets.

casionally serves this purpose. Cove or bracket lights may provide general illumination. A pendent light is often used over the table in the breakfast alcove.

Kitchen. The central light in the kitchen has a surrounding opal globe and is hung close to the ceiling to illuminate all parts of the room equally. Local shaded lights at sink and work centers are desirable to prevent one's shadow from falling on the work. A light panel is frequently set into the ceiling above the sink. (Fig. 220.) The diffusing glass cover reduces the usable light to an appreciable extent so that lamps of high power are necessary. Prismatic glass has been found efficient, and louvers are also recommended. Table 4 shows the number of foot-candles of light obtained with a 60-watt inside-frost Mazda lamp, backed by a reflector, placed 5 feet above the sink.

TABLE 4

COMPARATIVE LEVELS OF ILLUMINATION WITH VARIOUS COMBINATIONS OF REFLECTORS AND CONTROL DEVICES *

	Foot-Candles
Reflector and diffusing glass	5
Reflector and louvers	12
Reflector only	15
Reflector and prismatic glass lens	50

* John T. Bailey, *Some Practical Aspects of Lighting Kitchen Work Areas*, p. 728.

Lights for work surfaces are installed below cupboards. Figure 221 indicates the need for care in locating such soffit lamps, if glare is to be avoided. Polished surfaces on work areas also cause glare, whereas dark surfaces absorb light and decrease uniformity of illumination. When metal surfaces are used, the source of light should be as extensive as possible. Lumiline or fluorescent lamps supplying 25 watts per lineal foot of counter are adequate.

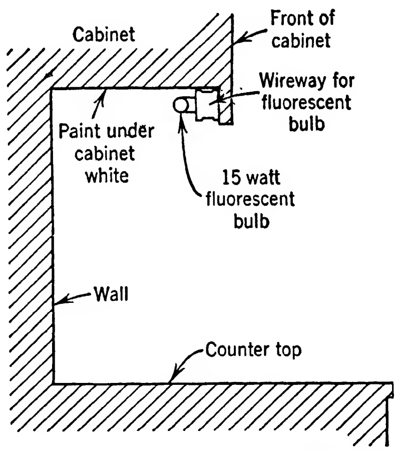

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FIG. 221. Lights above counters should be installed to reflect light away from the eyes of the person working at the counter.

Similar fixtures may be placed in the laundry, or dome-shaped metal reflectors, with a porcelain-enamel lining and a "skirt" around the edge to conceal the lamp, will prove satisfactory. (Fig. 222.) Cellar stairs should be as carefully lighted as those in the front hall. Frequently a red pilot light combined with the switch or placed above the cellar door indicates that the light is on.

Bedroom. Bedrooms are used for many purposes besides sleeping: sewing and studying, reading and letter writing, dressing and applying make-up. A central luminaire is, therefore, essential for general illumination. (Fig. 223.) Floor or table lamps at special locations and boudoir lamps meet other needs. Built-in fixtures over dressing tables recessed between wardrobes or shaded light panels either side of the floor-length mirror are suggested. Dressing-table lamps should be 20 inches tall and about 30 inches apart. They

should throw the light on the face rather than on the mirror. Light for reading in bed may be supplied by a floor lamp or a fixture above the head of the bed—either pinned to the wall or permanently installed—high enough to give a wide circle of light on the book or magazine. A spotlight fixture, which enables one to read without disturbing a second person occupying the same bed or room, is not

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FIG. 222. This fluorescent lighting unit, which pops out of the wall with the ironing board to provide "on the spot" illumination, was designed by Miss Myrtle Fahsbender, director of Home Lighting for Westinghouse.

desirable because of the great contrast between the brightness of the book and the surroundings. A small louvered light placed above the baseboard, which illuminates the floor and does not disturb the sleeper, is desirable. There is also a 6-watt night lamp which may be plugged into a low convenience outlet. If an opaque shade is attached above it, all the light will be directed downward. Bipost lamps are suitable for such installations. (Fig. 224.)

Lighting of closets is recommended, and when they are more than 18 inches deep it is considered mandatory.

Bathroom. Lights in the bathroom should be placed on either side of the mirror to illuminate both sides of the face equally. The new

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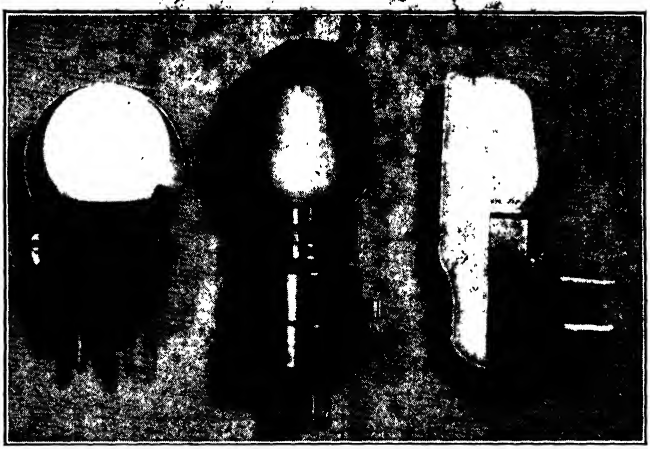
Fig. 223. An attractively and efficiently lighted bedroom.



General Electric

Fig. 224. Bipost lamps for night lights.

circular fluorescent tube which entirely surrounds a round mirror is an ideal arrangement. (Fig. 225.) Large bathrooms should also have a central fixture. If the shower compartment is completely enclosed, a moistureproof fixture should be installed in the ceiling. It should be controlled by a switch outside the shower space. A night light in the bathroom is a convenience.

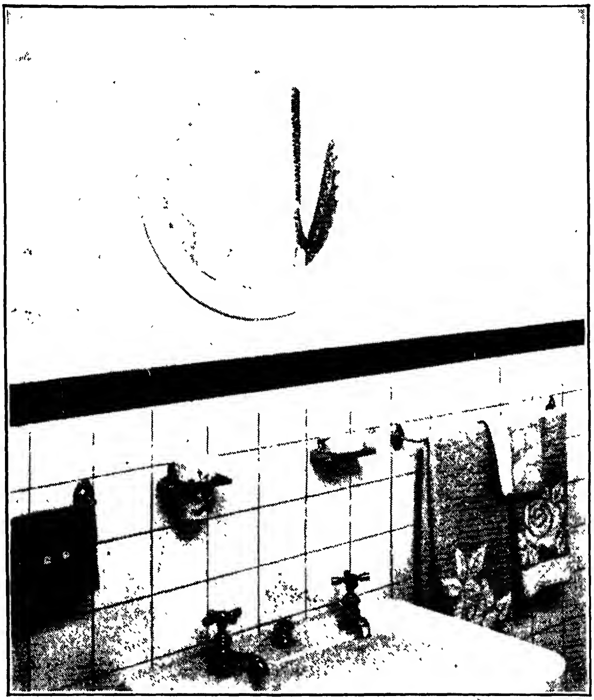


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FIG. 225. A "halo" of light from a circular fluorescent lamp concealed behind the mirror.

Porch. The sun porch is usually a definite part of the living rooms of the home and is lighted and supplied with convenience outlets in a similar manner. An unsheltered porch or terrace requires entrance lights and may have weatherproof convenience outlets for the connection of various appliances for outdoor meals or recreation. The extensiveness of its use depends upon the location of the house.

Recreation room. A basement recreation room is lighted in the same way as the living room. Adequate general lighting is especially desirable, and fixtures should probably be protected by wire guards

if table tennis is played or other games in which balls or rings are tossed around.

Rehabilitating old fixtures

It is not always possible to purchase entirely new lighting fixtures for a house already equipped with fixtures, but often the old equipment may be improved at comparatively little expense. All bare lamps may be shaded; dark shades replaced with light-colored ones; a pendent center light in the kitchen may be raised to the ceiling and enclosed in an opal diffusing globe; pendent lights may be changed to semi-indirect by turning the fixture around and adding a cone reflector and white-lined shade.

Needed convenience outlets may be supplied in the kitchen by attaching to the center light outlet a pendent convenience outlet that operates separately from the light. Strip convenience outlets may be installed in any room. Lamp sockets should not be used for attaching appliances. Many small modern appliances that use electricity as the source of heat are now rated at 1000, 1100, or even 1320 watts. Ordinary sockets are made for lamps of 200 watts at the largest; some portable lamps have special sockets for 300-watt bulbs. A 660-watt socket is manufactured and should be installed, if no convenience outlet is available, but should be used for appliances of 600 watts or less. If the appliance cord is separate from the piece of equipment, it should be connected to the socket first and then to the appliance; otherwise an arc is formed which gradually melts the metal in the socket. It is also bad practice to turn off a lamp by unscrewing it from the socket, since a little arc is always formed in this case, too.

"Packaged fixtures" are sometimes available. A package contains the necessary luminaires for a house; one even includes portable lamps. They are sold at different price levels, all comparatively inexpensive.

Several different types of luminaires which screw into a lamp socket are obtainable, also. One has a louver, delivering a high level of direct illumination; another a silvered bowl, a "sealed-in" reflector which does not need to be cleaned. This type gives a shadowless, glareless light, largely indirect.

Incandescent-filament lamp

The first practical filament lamp for home use was made by Edison. It had a carbon filament with an efficiency of 1.4 lumens per watt and a life span of approximately 48 hours. Later filaments were made

of metallized carbon, then tantalum, and finally tungsten. Today the tungsten-filament lamp is used for general lighting purposes almost exclusively. Tungsten-filament lamps are frequently known as Mazda lamps. In ancient Persia, Mazda was the god of light. What more appropriate name could have been found for our modern source of illumination!

No other known substance which might be used as a lamp filament is as efficient as tungsten in changing electrical energy into light over an extended period of time. It has four times the tensile strength of steel, a melting point of 6210° F., and an efficiency of 15 to 22 lumens per watt in lamp sizes commonly used in the home. Lamp efficiency increases as the filament temperature is raised and also with increase in wattage rating. When the tungsten-filament lamp was first introduced in November 1907, the 60-watt size cost $1.75. By September 1942, the price of the 60-watt lamp had decreased to 10 cents, and the 10-cent lamp gave twice as much light as the one at $1.75.

The resistance of tungsten increases with the temperature. The cold resistance of the filament, generally considered the resistance at room temperature, is much less than the hot resistance, 1/13 to 1/17 of it. Consequently the initial current through the lamp will be much greater than the flow after the filament is hot. This current surge is of only momentary duration, but it may affect fuse and circuit breaker operation and the design of switch contacts when a lot of lamps are turned on at one time.

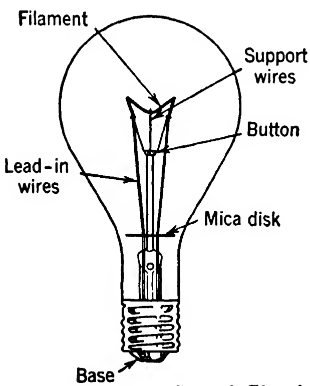

Fig. 226. The filament lamp.

Construction of lamps

A lamp bulb is a highly complicated device made with scientific precision. The materials are brought from all over the world, and the metal and glass parts are as carefully designed, fabricated, and assembled as those of the finest watch. If a single spot of a filament is only 1 per cent less in diameter than specifications call for, the life of the lamp may be reduced as much as 25 per cent, because of the more rapid evaporation at this spot.

The different parts of a filament lamp are shown in Fig. 226. The coiled tungsten filament is supported by molybdenum wires, which are held in place by insertion in a glass button at the end of a glass

rod. The filament wire is joined to two lead-in wires of nickel, copper, and steel, which are fused into the glass at the neck of the bulb to prevent air leakage. The fused wires must have the same coefficient of expansion as the glass. These wires in turn are connected by other wires to the screw base of brass. The end of one of the wires is connected to the contact disk at the end of the base. This disk is insulated from the rest of the base by a ring of glass or porcelain. The other wire is connected to the upper rim of the base. When the lamp is screwed into a socket the contact disk touches a metal point in the socket, the screw threads make a second contact, and the circuit is complete. Lamp filaments are of many different sizes, according to use. There are two types of Mazda lamps, those containing a vacuum and those filled with a mixture of inert gases.

Vacuum lamps

Incandescent lamps of less than 40 watts are made with a vacuum that prevents the cooling and oxidation of the filament. The wires in these low-wattage lamps are of small diameter and have a relatively large surface area. The wire would be cooled too much if the lamp were gas-filled and the amount of light per watt would be reduced. Even tungsten filaments gradually deteriorate. As deterioration takes place, the filament decreases in cross-section area and offers more resistance to the flow of the current, which consequently tends to be less, with a resultant diminishing of light. In the vacuum lamp the tiny particles of tungsten are thrown off equally in all directions and deposit a thin black film on the inside of the bulb. This film absorbs some of the light and decreases its efficiency.

Gas-filled lamps

Lamps of 40 watts and over are filled with inert gas, a mixture of argon and nitrogen in varying proportions, depending upon the wattage. In gas-filled lamps, the amount of the input energy which is removed from the filament by heat conduction and convection decreases as wattage is greater. Argon increases the efficiency of operation, but it cannot be used alone because it ionizes at the usual circuit voltages and tends to arc between the leads. The pressure of the gas, which under normal conditions is about equal to atmospheric pressure, hinders the evaporation of the tungsten and gives a lamp of reasonably long life even at the high temperature used. The hot gas tends to rise in the bulb, carrying with it the tiny particles thrown off from the filament. If the lamp is placed base up, the blackening

will occur largely around the base, and the efficiency of the rest of the bulb will not be reduced.

To hinder the black deposit, an active agent, known as a "getter," is applied to the filament or leads or may be introduced in the form of a gas. Bipost lamps contain a screen grid, fastened to each lead-in wire, that attracts the volatile tungsten particles, thereby giving a cleaner glass and prolonging the efficient light output. Gas conducts heat better than a vacuum, and consequently the gas-filled lamp is hotter to the touch.

Shapes of incandescent lamps

Although there are many different shapes of lamp bulbs, only seven are common in the home, and five of these are used in low-wattage ratings and primarily for decorative purposes. The shape of the bulb is designated by a letter or combination of letters with the following meanings: A, frosted inside; S, straight-sided; G, globular (round); F, flame-shaped; C, cone-shaped; T, tubular, PS, pear-shaped. (Fig. 227.) The size is measured in eighths of an inch, and a number accompanying the letter gives the diameter. To illustrate, G-20 is a bulb of G shape and 20/8 or 2½ inches in diameter. The A and PS bulbs are general-purpose lamps, the A lamp being most widely used. The A lamp is an improvement made in 1925 on the gas-filled lamp which was developed in 1913. The A lamp has a smooth outside surface and is frosted on the inside, gas-filled, and tipless. Inside-frosted lamps are more efficient in transmitting light than the outside-frosted ones. They are also superior in their ability to shed dust. The tipless lamp is more easily handled than one with a tip and is less subject to accident in the home.

Many unmarked lamps are imported; they are usually not as efficient in level of illumination or hours of life as the American-made lamps.

Lamp-bulb finishes and colors

Frosted lamps are preferable for use where there is any likelihood of their being within the range of vision, because of the better diffusion of the light and elimination of glare. The brightness of a light depends upon the candle power per square inch. The Mazda filament has a brightness of 6500 candle power per square inch; a frosted lamp, from 50 to 60. According to authorities, the surface brightness of lamps in the line of vision should not be greater than 3.5 candle power per square inch, a further argument for shaded lights.

White-bowl lamps have a white translucent enamel finish on the inside of the bulb. About 80 per cent of the light incident on this coating is directed upward, the other 20 per cent being diffused

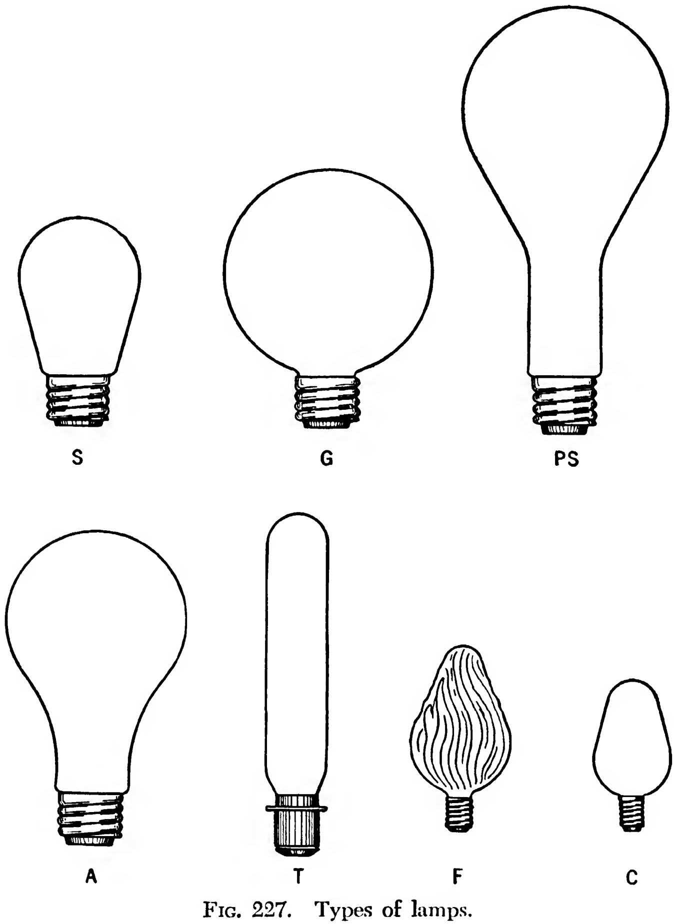

Fig. 227. Types of lamps.

through the glass. The lamp may be used within the line of vision without causing uncomfortable glare.

The blue daylight lamp is made of a special blue glass that absorbs the red and yellow rays given off by the filament and provides light that is similar to daylight in color. This lamp is desirable for matching colors—it may assist the homemaker to find the green bug among the broccoli flowerlets—but the blue glass absorbs about 45

per cent of the light and two bulbs must be used to equal one A lamp of equal size in light output.

Silvered-bowl lamps are made in all the standard sizes beginning with the 60-watt size. A metallic coating of pure silver is sealed onto the bulb with an electrolytic coating of copper, over which an aluminum or bronze finish is applied. These extra coatings protect the silver from deterioration. All the light is directed upward so that this lamp is especially adapted for indirect-lighting fixtures.

Various colored lamps are used for decoration. They are frequently so inferior in light transmission that a much higher wattage must be used to approximate the foot-candles from an A lamp of equal size. The bulbs may have the coating on either inside or outside. The outside-coated lamps may be affected unfavorably by certain atmospheric conditions, and they collect dirt readily and are not easily cleaned. However, a method has been developed for finishing colored lamps with a permanent ceramic glaze, in which the pigments are fused into the glass.

Lumiline lamps

Lumiline lamps are tubular in shape. The filament extends the length of the tube and gives a continuous line of light. Contact points at each end fit into a special socket. At first made only of clear glass, they are now manufactured of white opal glass and in certain colors. The opal lamps are sometimes supplied with molded plastic caps in pastel colors, and one lamp is made entirely from plastic in white or ivory, either for stationary installation or as a portable fixture with cord and plug. The lumen output of lumiline lamps is less than that of standard bulbs because of heat loss due to additional supports needed for their installation.

Lamp bases

With the exception of lumiline lamps, filament lamps used in the home have screw bases. The medium screw is the most common. Miniature, candelabra, and mogul bases are also found. Decorative lights frequently have the candelabra base, and strings of lights in series have the miniature base. The mogul is a heavy-duty base, used on high-wattage lamps. The three-way bulb has a medium or mogul base of modified form. This base has an additional center contact which allows the two filaments of the lamp to be connected singly or in combination. A special disk base is sealed into each end of the lumiline tube and snaps into a holder adapted for its support.

Bipost lamps make pin-type contacts in a convenience outlet. Since considerable heat is conducted from the filament to the posts, the socket should be designed to withstand a temperature of at least 550° F.

EFFICIENCY OF INCANDESCENT LAMPS

The ratio of light output to power consumed gives the efficiency of a lamp. The amount of light received is proportional to the tem-

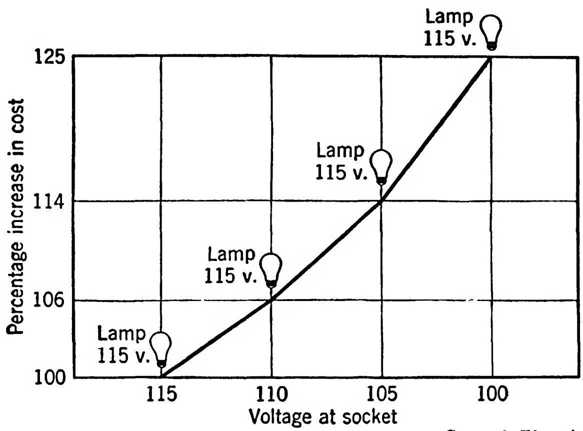

FIG. 228. Increase in cost when lamps are used on low-voltage circuits.

perature of the filament. The tungsten filament has a melting point of about 6120° F.; it becomes white hot when the electric current passes through it, and gives a very brilliant white light. In some of the lamps the filament is only 0.003 inch in diameter, but so long that it must be wound in a spiral, a form which gives high efficiency, being mechanically stronger, with less surface exposed to the circulating gas than when straight. The coils supply additional heat to one another. The coiled coil has approximately 10 per cent greater efficiency than the single coil. Efficiencies of lamps increase with power because the larger filaments more easily withstand the operating temperature and heat loss is lessened.

Since the original cost of the lamp is small compared to the price paid for the electricity which the lamp burns during its lifetime, it is poor economy to buy inefficient types of bulbs or lamps of too small power. For example, a 100-watt lamp gives a 105-candle-power light; a 25-watt lamp only 18 candle power. It would take approximately six 25-watt lamps or 150 watts to give the same amount of light as

that obtained with the 100-watt bulb. These figures indicate that one or two large-watt lamps are preferable to several small ones. All lamps have a certain lifetime, depending upon the use for which they were designed. In 50- to 100-watt sizes, they average 1000 hours. Lamps should always be operated at the voltage for which they are marked; operated at too high a voltage they burn out more rapidly; at too low a voltage the light output drops off, useful current is wasted, and the cost per watts consumed actually rises. Figure 228 illustrates the increase in cost when a lamp is used on a lower-voltage circuit than that for which it is rated.

FLUORESCENT LAMPS

The fluorescent lamp is a vapor lamp through which an electric discharge passes. It is tubular with an electrode sealed into each end.

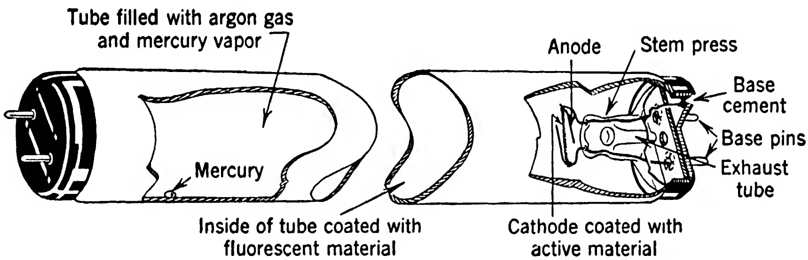

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FIG. 229. Inside of the fluorescent tube.

The tube contains a trace of mercury under low pressure and a small amount of argon which acts as a starter in conducting the electricity. The hot-cathode tube is best adapted for operating conditions in the home. The hot electrodes give off electrons much more readily than the cold ones, and consequently the lamps can operate on a lower-voltage circuit. The electrodes are made of coiled tungsten wire coated with barium or strontium oxides, which are good electron-bearing materials. (Fig. 229.) When the switch is thrown, a current passes through the tungsten filament and heats it to approximately 950° C. At this temperature an abundance of electrons are driven off from one electrode and flow toward the other. The electrons supposedly collide with the gas atoms in their path, producing a state of excitation in the gas which causes ultraviolet radiation at a wavelength of 2537 angstroms.

Mercury-vapor lamps have been used in factories and drafting rooms for some time but were not considered desirable for home use

because of the color effect. Fluorescent powders, known as phosphors, have been developed which convert the short invisible ultraviolet rays into a light that is very similar to natural daylight—with some slight variations depending upon the powder used. The tubular bulb is coated on the inside with the fluorescent powder. The particles in these powders are extremely small, 0.00008 to 0.0002 inch in diameter. The size must be carefully controlled. When not lighted the coatings are mat white and translucent. There are four whites: 3500 white, daylight, soft white, and 4500 white, produced by a mixing of the phosphors. Green, blue, pink, red, and gold coatings are also available. In the case of the red and gold, the tube is first

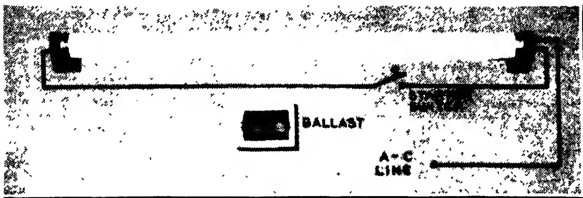

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FIG. 230. Preheat type of fluorescent lamp with ballast in series with tube.

covered with a pigment and then an inner coating of the fluorescent powder is added. Because of this pigment, the gold and red lamps do not appear white when unlighted.

Fluorescent lamps require a current-limiting device for operation; all lamps obtaining light from electric discharge sources do. Otherwise the lamp would consume so much current that it would destroy itself. This ballast, as it is called, is placed in series with the lamp and is specifically adapted for the size of lamp and type of circuit, within a definite voltage range. (Fig. 230.)

A special starter switch is also needed. The switch completes a separate circuit through the electrodes so that they may be preheated. After a few seconds the starter circuit is opened and the tube lights. Ballast and starter circuits consume energy which should be added to the wattage rating of the lamp for an accurate appraisal of cost of operation.

Some lamps have an instant-start ballast, which requires no preheat period. The ballast in this case is designed to deliver a high starting voltage, and then normal voltage for operation. Because no preheat circuit is needed, instant-start lamps need only one terminal at each end, and not the bi-pin base of the preheat types.

Fluorescent lamps have a life of 2000 to 2500 hours or more when used properly. The electrical emission coating on the cathodes is gradually used up, causing a blackening at the ends of the tube. The frequent starting of a tube hastens the depletion of the active material, and lamps should be allowed to operate for several hours at a time if possible. When the emission oxides are exhausted, the light will tend to flash on and off. Occasionally the filament coil may wear thin

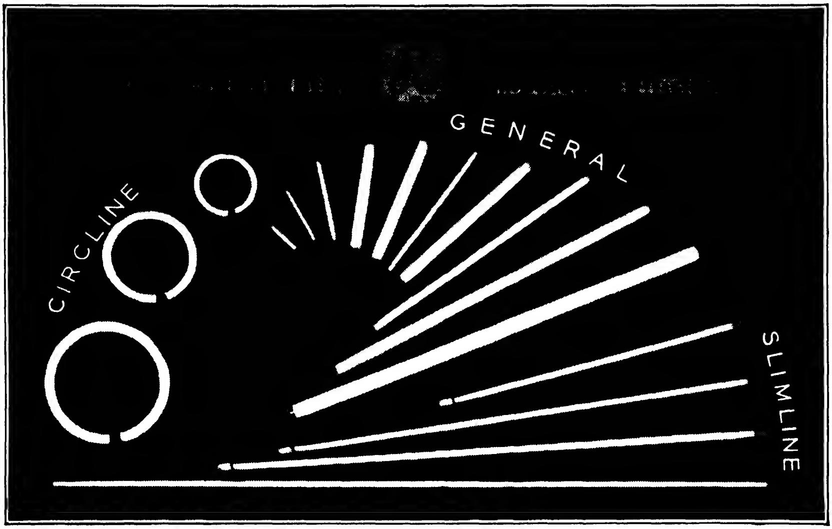

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FIG. 231. Fluorescent lamps.

and break. Fluorescent lamps operate most successfully at an ambient temperature of 80° F.

The first fluorescent lamps were introduced commercially in 1938. Slimline and circline tubes have now been added to the offerings. (Fig. 231.) Slimline tubes are the instant-start type. These tubes are very satisfactory for installation in coves, in bookcases, and under valances and cabinets. They are less glaring than filament lamps; they are cool and therefore much more efficient. The 32-watt circular fluorescent has a light output of 1600 lumens. The output of the 100-watt white lamps varies from 3300 to 4200 lumens. Certain colors, noticeably blue, green, and yellow, are intensified under fluorescent lamps while orange and reds are dulled and may even appear brownish. Therefore, care must be exercised in the selection of colors to be used under fluorescent illumination.

Lamps for special purposes

Health lamps. Not only is the sun our original and still most powerful source of light, but at either end of the visible spectrum of its light are other useful rays not seen by the eye. Beyond the red end the infrared rays give us heat, and at the opposite end the ultraviolet rays possess certain therapeutic properties. Ultraviolet, in wavelengths between 2900 and 3100 angstrom units, activates vitamin D in the body, which is essential for the proper absorption of calcium in correct bone formation. Its lack causes rickets. The angstrom unit is 10^{-7} millimeter, or a ten-millionth of a millimeter, in length.

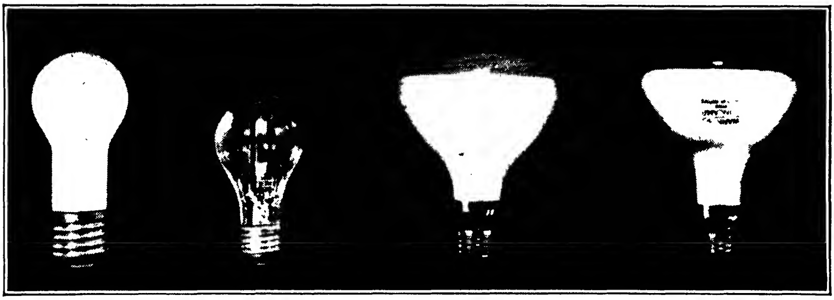

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Fig. 232. Types of sunlamps—S-1, S-4, RS-4, and RS.

From very early times it has been known that the sun's rays had healing power. A tablet dug up in Egypt shows an early Pharaoh with his wife and children, and a basket of fruit, enjoying a sun bath. Lest the true meaning be missed, rays from the sun above the group are brought down to strike against each member. The ancient Greeks and Romans had their solaria. The sun porch has been added to the modern home, but glassed in for use in all weathers. Ordinary window glass does not transmit ultraviolet light, however. Not all ultraviolet rays are equally valuable; some are even harmful to the more sensitive organs of the body, as the eyes, but these harmful rays are absorbed before the sun's rays reach the earth.

Because of the difficulty of obtaining sufficient sunlight in some latitudes, especially during the winter months, artificial sources of ultraviolet have been developed. Four types of Mazda sunlamps are available for household use. They are designated by the symbols S-1, S-4, RS-4, and RS. (Fig. 232.) The bulbs are made of a special glass that transmits ultraviolet radiations in the wavelength region of 2900 to 3100 angstroms but absorbs radiations of shorter wavelength which would be harmful to the eyes. The S-1 was the earliest form.

(Fig. 233.) The lamp is fitted with a transformer that allows it to be connected to the 115- or 120-volt 60-cycle alternating-current circuit, commonly found in the home. The bulb contains two tungsten electrodes, a V-shaped tungsten filament, and a globule of mercury. When the current is turned on, the V-shaped filament is heated to incandescence, the heat vaporizes some of the mercury to form an arc between the tungsten electrodes, and ultraviolet radiations are given

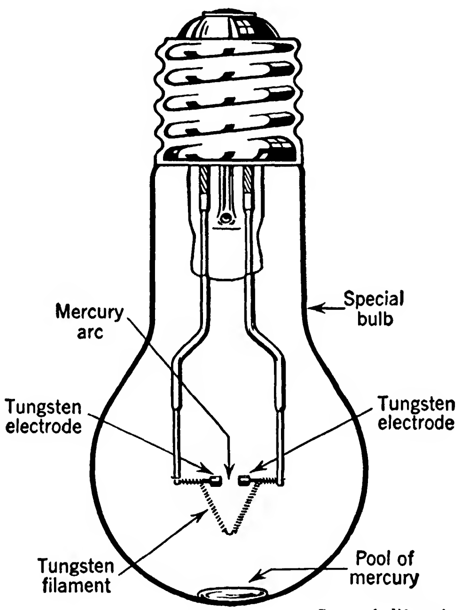

FIG. 233. S-1 Mazda lamp.

off. The Mazda sunlight lamp gives sufficient light to be used for play, or reading and sewing, so that it may serve a dual purpose.

The S-4 and RS-4 do not produce visible light. The RS-4 was designed primarily for poultry and farm animal applications.

The RS lamp has a ballast and bimetallic starting switch built into the bulb, so that no auxiliary equipment is needed. Because of this construction the lamp produces not only ultraviolet radiations but also light and heat. (Fig. 234.)

If a reflector is used with the ultraviolet lamp, it should be of chromium or aluminum. Other materials tend to absorb rather than reflect the rays.

Care must be taken not to use the lamp at a short distance a very long time, until the body has become accustomed to the exposure.

Erythema does not usually appear during the exposure but develops afterwards, and it will be as painful as a severe sunburn acquired out of doors if the exposure is too long.

Infrared radiation. Any incandescent-filament lamp will produce sufficient infrared radiations for home use. Special heat lamps are similar in construction but designed for longer life and therefore less light output. They may be used to relieve pain whenever heat appli-

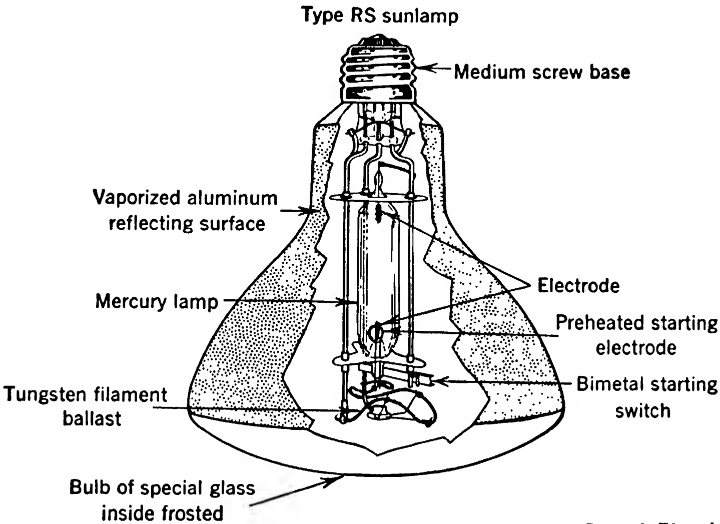

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Fig. 234. RS lamp.

cation is the recommended method of treatment. During use, care must be exercised not to overheat any combustible materials in close proximity to the lamp.

Black-light lamps. Black-light lamps use ultraviolet radiations around the 3650-angstrom line. Bulbs for this type of lamp are made of a special glass that transmits this wavelength, which is very effective in activating fluorescent materials. The absence of visible light is usually essential. Such a lamp will probably find a certain amount of application when television radio sets are more widely used in the home.

PAR and R lamps. PAR (parabolic aluminized reflector) bulbs are available for spot- or floodlighting of the home grounds. The lamps have a lens on the end and an inside metallic reflecting surface. The glass is heat resistant so that the bulb can be safely used out of doors. The R lamps are similar in construction but are not made of heat-

resisting glass, so that their use is limited to inside the house unless special protection against rain and snow is afforded.

Light for decoration. Light may be used for decoration as well as for utility, and the possibilities here are almost limitless. Great care must be exercised in the use of color. Soft tints rather than bright reds, blues, or greens will have the desired effect in creating a mood. Most of the light ornaments use the tiny 10-watt lamp with the intermediate screw base and are not expensive to operate. These 10-watt lamps are placed inside china figurines, softly tinted flowers of shell, and cut crystal balls. Metal figures are silhouetted against a lighted screen or hold illumined urns. A translucent vase may be lighted from within or from below. Recently thin sheets of marble surfacing the fireplace have been illuminated from the rear—a form of panel lighting. Where members of the household wish to rest and listen to the radio, several such light ornaments in a room may give sufficient light. At other times they give life to an otherwise dull corner. One or two of them may be left lighted when the family is out in the evening; it is more cheerful to return to a room so lighted than to a dark house. In ornamental lighting low voltage is not particularly detrimental; the life of the lamp is prolonged without ill effects on vision.

A lighted figurine in a low bowl of flowers is a lovely centerpiece for the dining table. For special dinners and other parties strings of Christmas-tree lights may be utilized in making miniature electric candles, for illuminating colored balloons, as the centers of artificial flowers, and for a dozen and one other interesting and unique forms of decoration.

The grounds also may be lighted, not only at Christmas time when evergreen trees in the yard are decorated but during the summer; lights on a pool or fountain or on an interesting piece of statuary with its background of shrubbery will change a dark corner into fairyland. Care must be taken to use non-metallic sockets and weatherproof fixtures. The PAR bulb may be used, as has been noted, to give spot- or floodlight in the garden.

Modern trends in lighting

Modern trends in home lighting have produced some interesting features. Some of these have already been mentioned, but they will be briefly summarized in the following paragraphs.

Cove lighting is suitable for both living and dining room. Fluorescent, lumiline, or the 10-watt lamp with intermediate screw base is

used in houses already built. The lamps, 6 to 9 inches apart, may be placed above a plate rail and hidden from view by a metal strip painted the same color as the wall, or a metal trough may be installed. If several circuits are provided, lamps of different colors may be used and a pleasing variety of effects obtained. In new construction the ceiling is sometimes built in two levels, with the lamps placed around the edge of the lower level to illuminate the central higher portion. In such an arrangement the light must not be too bright or the illuminated area becomes a direct source. When high-power lamps are used, the light should spread over the entire ceiling and the upper part of the walls. Indirect lighting behind window valances and from recessed units in niches and bookcases is a modification of cove lighting. Strip outlets may be used.

The most recent trend is to build light panels into the room as a part of its construction. These panels, placed either in the ceiling or in the walls, are made of diffusing glass which gives a most satisfactory even light of the desired intensity throughout the room and almost entirely eliminates shadows. Behind the panels are incandescent or fluorescent lamps backed by a reflecting surface. The glass should be thick enough so that the lamps are not visible, and it should be uniformly illuminated. Artificial windows lighted from behind to give an appearance of sunshine greatly improve an inside room. When installed during the construction of the house, panels cost little if any more than regular better-grade fixtures.

Many of the modern fixtures are made of a series of glass planes or fan-shaped panels set in metal grooves. These fixtures give semi-indirect lighting and are effective in the proper setting, but they require very frequent washing if they are to remain attractive and efficient.

A press button to illuminate the keyhole at night, death-ray bug exterminators for deck lights, and the bacterial sterilamp for killing microorganisms are other conveniences that make for comfortable, healthful living.

Effect of surroundings

The amount of light that actually gets down to where it may be used on the working plane is important. In cooperation with the physics department, carefully controlled experiments were carried on at Iowa State College in a room 12½ by 13 feet, to determine the effect of the color of the ceiling and walls upon the useful light from a central fixture of five unshaded lamps. Measurements were made on a plane 30 inches from the floor. Mazda B, A lamps, ivory lamps,

and flame-tint lamps were tested. The silver-gray paper of the walls was used for one set of experiments, and was then covered with colored hangings of tangerine, red, Yale blue, and black, for a series of tests.

The results of the experiments showed that the A lamps were highest both in installation and utilization efficiencies, ivory lamps ranked next, and the flame-tint lamps were the least efficient. Wall coverings of low reflection ability and dark furniture in the room diminished the amount of useful light. Flame-tint bulbs used with a low-reflecting background were most irritating to the nerves. The flame-tint lamp is low in blue wavelengths. The interior finish of a room, its furnishings, and the type of lamps are all important in obtaining the level of illumination needed.

The Illuminating Engineering Society in its booklet, *Recommended Practice of Home Lighting,* makes the following report.

A room is more satisfyingly lighted when the ceiling, floor and walls reflect light in the following percentages: ceilings between 65 and 80 per cent; floors between 10 and 20 per cent; and walls between 35 and 55 per cent. In utility rooms where efficiency is of greater importance the higher values are better. Lower values are permissible, though not desirable, in rooms where decorative treatment is of paramount interest and critical seeing is not involved.

Today the paint industry offers a considerable choice of colors in various tints and shades that will add distinction to a room and at the same time contribute to its illumination by reflecting a large percentage of the light. The following table lists the approximate percentage of light reflected by typical colors and finishes used in residential interiors.

Color	*Per Cent of Light Reflected*	*Color*	*Per Cent of Light Reflected*
White	85	Dark	
Light		Gray	30
Cream	75	Red	13
Gray	75	Brown	10
Yellow	75	Blue	8
Buff	70	Green	7
Green	65	Wood finish	
Blue	55	Maple	42
Medium		Satinwood	34
Yellow	65	English oak	17
Buff	63	Walnut	16
Gray	55	Mahogany	12
Green	52		
Blue	35		

The type and texture of the paint used is also important. As a general rule, the wall and ceiling surfaces should be *mat* and not gloss. A mat finish spreads or diffuses the light in all directions. A gloss surface mirrors the light and reflects a bright spot that can produce annoying glare.

Colors are grayed and tend to lose their vibrance and true hue in too dimly lighted rooms.[1]

EYESIGHT CONSERVATION

All this discussion of light is valuable, as it has a bearing on the protection and care of eyesight. Sight is the only one of the senses that is dependent upon an outside agency for its functioning, and it is, therefore, doubly important that this agent should be adequate in doing its part. Dr. I. B. Metzger, a former president of the Pennsylvania State Board of Medical Education, is authority for the statement that "25 per cent of our energy is consumed in seeing with normal eyesight and proper illumination." How much more energy is needed when the eyesight is below normal or the illumination insufficient!

Primitive man lived out of doors, did few tasks that required close vision, and went to rest at nightfall. The level of his illumination was high, several hundred times, perhaps at noon even several thousand times, the amount of light that modern man receives from artificial sources. It would seem impossible to use too much light, and that is the opinion held by some outstanding authorities, who recommend from 100 to 1000 foot-candles for reading black print on white paper and from 1000 to 10,000 for sewing on dark goods. Other investigators have found that visual acuity increases with an increase in illumination from 3 to 11 foot-candles, but more light has little if any effect. Both groups would undoubtedly agree that the objective sought is maximum efficiency and comfort, an objective that is probably attained when seeing is performed with assurance, ease, and speed. No hard and fast rule can be stated; eyes differ, and light requirements vary with age. Comfort is not always a safe criterion, for it is frequently a matter of individual preference and depends on habit, which changes with time. Real eye discomfort is associated with aching, redness, burning, scratchiness, and a sensation of fatigue. Older people need more light than younger, since the size of the pupil decreases with age and the eye tissues are less translucent.

[1] *Recommended Practice of Home Lighting,* Illuminating Engineering Society, New York, June 1945, pp. 13–14.

The fact that sunlight is high in foot-candles does not prove that artificial illumination should be. Sunlight comes from a distance and is adequately diffused by sky and atmosphere; the source of artificial light is near at hand. Small concentrated sources often produce sharp shadows and harsh effects, and consequently cause eyestrain and, indirectly, mental and nervous strain. The important consideration is to have the light properly directed.

The need for superior artificial light is realized when it is known that about 20 per cent of elementary school children have faulty eyesight. The New York State Health Department found that children living in the country were more subject to defective vision than children in the city, owing perhaps to better artificial light in urban homes. When the children have grown to college age the percentage has doubled and 40 per cent do not see normally. This condition seems doubly distressing when it is learned that over 70 per cent of all muscular energy needed for work and recreation is dependent upon seeing, that 80 per cent of the impressions received from the surroundings come through the eyes.

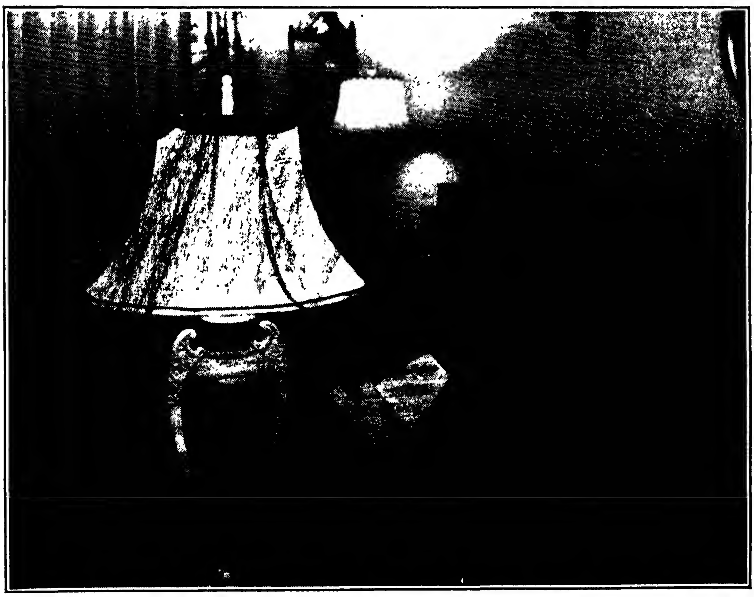
The eye becomes defective through use as well as abuse. The pupils gradually dilate under work requiring continuous or great visual effort, and only partially recover during the night—all too short at times—or over a weekend. "Good lighting should prevent or reduce defective vision and unnecessary waste of human resources." [1] Eyestrain frequently results not so much from defective eyes as from the effort of good eyes to see when there is not enough light for sight.

Insufficient and wrongly directed light causes the child to hold his book too near his eyes, and doing this habitually leads to nearsightedness. If a person is not able to read easily with the printed page 12 to 15 inches from the eye, something is wrong with either the sight or the light. Children's eyes should be carefully protected from unshaded and "spotty" light, where there is too great contrast between the illuminated and unilluminated areas of a room. (Fig. 235.)

Eyestrain resulting from the attempt of the eye to adapt to unfavorable conditions of gloom or glare may not always reveal itself in eye trouble, but in headaches, nausea, indigestion, sleeplessness, and irritability. Among school children lack of interest, failure to concentrate, sleepiness, and apparent laziness may all be caused by faulty sight. Luckiesh and Moss report an investigation made in

[1] W. E. Barrows, *Light, Photometry and Illuminating Engineering.*

(*a*)



(*b*) *Westinghouse*

Fig. 235. (*a*) Too sharp a contrast between light from lamp on table and the rest of room causes eye discomfort. (*b*) Additional light sources in the room eliminate the contrast and increase seeing ability.

grade schools which showed that 85 per cent of the children with imperfect vision were retarded in studies. Only 14.6 per cent of the children of normal rank had defective vision.

SCIENCE OF SEEING

More and more investigators have come to realize that vision involves something besides the conversion of radiant energy, that it is a real science, the science of seeing. The ability to see with certainty and ease is increasingly important because of the growing number of complicated occupations that demand keen vision and the almost universal driving of automobiles. Seeing is definitely tied up with human reactions.

Luckiesh lists the following factors as significant in influencing visibility: size of object and details—dependent in part upon distance away; brightness, and contrast in brightness with surroundings; color contrast; precision of task; speed of seeing required; normal or subnormal vision; pupil size and retinal adaptation, affecting visual acuity; fatigue of eye muscles; distractions.

With the present emphasis on a higher level of illumination, brightness and brightness contrast have demanded special consideration. Surface brightness should not exceed ½ candlepower (cp) per square inch when in direct view. In marginal view it may be as high as 3 candlepower per square inch. Out-of-doors contrast in brightness is usually 1 to 18–25 candlepower; in a luminaire with polished surfaces it may be 1 to 2000 or 3000 candlepower. Working surroundings should not be so bright as to emphasize insignificant details and distract attention. It has been found that the sensitivity of the visual sense is generally greatest when brightness of task and surroundings is approximately the same. On the other hand, if the brightness or contrast is low, more light will increase seeing facility. For example, compare the ease of reading the usual book or magazine with a newspaper or telephone directory. There is no question as to which requires more illumination. A moderate amount of brightness and color is desirable. They stimulate and hold the attention of the worker. Shadows, too, are valuable if they make seeing easier.

Defective eyes need two to three times as much light as normal eyes. Interesting experiments have shown that light-eyed people require a higher level of light than dark-eyed for the same task. Light eyes are also very much more sensitive to glare, perhaps because the light iris, being more transparent, transmits more light. Negroes were found to see two to four times better at night than white persons.

Such information is valuable in determining which individuals should exercise special care in night driving. Glare apparently bleaches the visual purple, which is essential for sight. Vitamin A aids in regeneration of visual purple. Dairy products, green vegetables, and carrots especially are a source of this valuable vitamin. Carotene, a vitamin-A concentrate, is taken by color-matching inspectors to relieve eyestrain and consequent fatigue.

Care

Keep the lamps and fixtures clean. Dust accumulating over months will absorb as much as 50 per cent of the light otherwise available. The deposit of dust is so gradual that the consumer is not conscious of the dimming until it becomes very bad, but all the time he is paying more and more for light he does not get. Clean fixtures and lamps frequently and at regular intervals. Inverted fixtures should be wiped out every two weeks and the pendent types washed at least once a month. Avoid installing luminaires that catch dust easily and are cleaned with difficulty. Some of the new modernistic styles belong to this class. Bulbs may be wiped off with a damp cloth; they should not be immersed in water. The metal supports of the fixtures are often finished with a protective coating of lacquer, which will be destroyed by acids. Wiping off the dust with a damp cloth and then rubbing with a dry one is usually sufficient to keep the metal in condition. Ceilings should also be kept clean if they are to reflect light adequately.

It is undoubtedly true that the amount of illumination would be doubled if all fixtures and lamps in the many homes of the country were washed and the ceilings whitened on the same day. Water is cheaper than watts.

Cost

Adequate wiring usually costs 2 to 3 per cent of the total cost of the house, and the fixtures another 2 to 3 per cent. Compared to the cost of plumbing and plumbing fixtures, which runs from 10 to 15 per cent, the lighting cost is small. When the benefits and comforts derived from efficient lighting and a sufficient number of convenience outlets are considered, it should be quite unnecessary to urge the builder not to seek to economize on his electric installation. The most satisfactory way is to employ an expert to lay out the wiring plan, and then personally supervise the installation to guard against any changes.

The cost of all lamps is less than formerly, and it is estimated that increase in their efficiency has provided over 25 million dollars of added light free.

OTHER SOURCES OF LIGHT

Regardless of personal desires in the matter, a good many homes are so located that it is not possible to have electricity for lighting. Practically any illuminant will supply good lighting, if used in sufficient amount and if properly directed. The simplest system that will give the needed light is to be preferred. All light sources other than electricity are of the flame type, and, therefore, have to be kept away from flammable materials. Fixtures must be within reach for ignition and control. The location of lights of these types is further limited because flames usually have an upright position and need the oxygen of the air for complete combustion. Improper combustion causes a deposit of soot on the chimney and blackening of walls or ceiling. The use of the Welsbach mantle with the gas flame and the mantle in the Aladdin coal-oil lamp gives a steady clear white light. A flickering light is injurious to the eye. For an equal amount of fuel consumed, the amount of light is quadrupled by using a mantle.

Rules for the proper shading of light sources are as applicable to these lights as they are to electric lamps. Since the possible positions for most of the flame lamps are somewhat limited, the shade is essential in directing the light where it is needed. Reflectors placed behind or over lights will often increase their efficiency.

Summary

The essential points brought out in this consideration of the various phases of home lighting may be summarized as follows.

1. A ceiling outlet in every room or a high level of general lighting supplied by cove, valance, or other concealed lighting.
2. At least one light in every room operated by a switch at the entrance to the room.
3. Sufficient switches to enable a person to turn on lights as he enters and turn off lights as he leaves a room without retracing steps.
4. A double convenience outlet on every wall space large enough to hold a piece of furniture, usually spaced from 6 to 10 feet apart.
5. Sufficient lights conveniently located to supply all needs without eyestrain. "Light is cheaper than vision."
6. All lights shaded; shades deep enough to conceal the lamp, broad enough to give a wide circle of light, white-lined to reflect light

well. Shades have a fourfold function: they protect the eyes, direct the light, soften shadows, and serve to decorate.

7. Lamps of sufficient wattage to compensate for light lost in transmission and absorption.
8. No strong contrasts of light and shadow, so-called "spotty" light.
9. No glare from reflection. Good reflecting surfaces in ceilings and walls. Light-colored mat surfaces are the most satisfactory.
10. A source of steady light.
11. Clean lamps and fixtures. "Water is cheaper than watts."
12. Light ornaments to give charm and express individuality.

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